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14. ABSTRACT
Fundamental problems in the increasingly interdisciplinary areas of research have never been as challenging and exciting. An exceptional open forum of learning, discussion and exchange of ideas has taken place over the last 39 months, at NCSU (ECE Dept.) with full access of the seminars as well as time to the invited distinguished speakers to all triangle communities and in particular, to UNC-CH, NC A&T, Duke Universities and all industry in the triangle.
The topics covered the broad areas of information sciences, nanotechnology, mathematics, and physics. The list of

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Report Title

Final Report: Interdisciplinary Distinguished Seminar Series

ABSTRACT

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TOTAL:

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Patents Awarded

Awards

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Abstract

Fundamental problems in the increasingly interdisciplinary areas of research have never been as challenging and exciting. An exceptional open forum of learning, discussion and exchange of ideas has taken place over the last 42 months, at NCSU (ECE Dept.) with full access of the seminars as well as time to the invited distinguished speakers to all triangle communities and in particular, to UNC-CH, NC A&T, Duke Universities and all industry in the triangle.
The topics covered the broad areas of information sciences, mathematical phyiscs and engineering, computer science and mathematics. The list of speakers included leaders of the respective fields from the US and abroad. All the abstracts of the invited seminars are included as an appendix in this report. This interaction has also led the PI's upcoming book on Geometric Signal Processing.

1. Introduction

We have been animating a vigorous and very educational seminar series which have included world authorities in their respective fields of research expertise.
As originally planned our strategy is to have an overarching framework across different disciplines to not only attract different researchers as an audience but to also promote interaction and synergy between them.
This forum approach has indeed led to healthy debates of viewpoints as well as of conceptual strategies. A number of collaborations have been initiated and papers published by seminar participants and guests. The resulting synergy has also helped expose the wealth of technological activities around the RTP area, as well as the vibrant atmosphere for research and innovation.
The themes selected for the seminars have covered the areas of fundamental sciences with an applied angle, such as communications, to ocean wave modeling in mathematical physics and of great relevance to information sciences and systems, manifold learning, in algebraic geometry/mathemactic of crucial importance in learning and artificial intelligence, as well as more applied engineering sciences in systems and information sciences and genomics and bioinformatics in biology.
An accessible archive of all the seminars are directly available for streaming on the web, and the contacts to the speakers as well available.
We have had participation from Duke University, Univ. of N Carolina-CH, NC A&T, and many other universities across NC and the nation by remote access.
In summary, this funded Interdisciplinary Seminar Series have not only brought the best in the disciplines of Information Science and Systems, but as an initiative has also greatly served the academic communities in their educational mission as well as in their research training of graduate students (future professionals to serve the community), and has most definitely helped enhance the professional growth of researchers/engineers in the academic, government and industrial laboratories. Furthermore, and in
staying true to our university outreach mission to the community, as a land grant university, this effort has afforded to have a medium to researchers/engineers an opportunity for interaction, for contact as well as for consulting and advice.

2. Seminar Abstracts

Metric Geometry in Shape Matching

Dr. Facundo Memoli, Postdoctoral Fellow, Mathematics Department
Stanford University

Dr. Facundo Memoli spoke on Friday, September 17th, 2010 at 1:00PM in Engineering Building III, Room 2213

The problem of object matching under invariances can be studied using certain tools from Metric Geometry. The central idea is to regard objects as metric spaces (or metric measure spaces). The type of invariance one wishes to have in the matching is encoded by the choice of the metrics with which one endow the objects. The standard example is matching objects in Euclidean space under rigid isometries: in this situation one would endow the objects with the Euclidean metric. More general scenarios are possible in which the desired invariance cannot be reflected by the preservation of an ambient space metric. Several ideas due to M. Gromov are useful for approaching this problem. The Gromov-Hausdorff distance is a natural first candidate for doing this. However, this metric leads to very hard combinatorial optimization problems and it is difficult to relate to previously reported practical approaches to the problem of object matching. I will discuss different adaptations of these ideas, and in particular will show a construction of an L^p version of the Gromov-Hausdorff metric called Gromov-Wassestein distance which is based on mass transportation ideas. This new metric leads directly to quadratic optimization problems on continuous variables with linear constraints. As a consequence of establishing several lower bounds, it turns out that several invariants of metric measure spaces are quantitatively stable in the GW sense. These invariants provide practical tools for the discrimination of shapes and connect the GW ideas to several pre-existsting approaches.

Facundo Memoli is a postdoctoral fellow in the Mathematics Department at Stanford University. His research interests are in shape and data analysis and in metric geometry. Facundo received his B.Sc. and M.Sc. in Electrical Engineering from the Universidad de la Republica in Uruguay, and his Ph.D. in Electrical Engineering from the University of Minnesota.

Mathematical Modeling of Shape

Dr. Huiling Le, Professor, Mathematics
University of Nottingham, UK

Dr. Huiling Le spoke on Friday, September 24th, 2010 at 1:00PM in Engineering Building III, Room 2213

Many different models for shapes have been introduced and studied. In this talk, we discuss how the Kendall shape spaces for landmarks are defined. We then look at, under this model, how difference between shapes are measured and how the concept of Euclidean means has been adapted to account for features of the geometry and how shape change of data over time are modeled.

Dr. Le finished her Ph.D. in mathematics at Cambridge University in differential geometry. She was one of the pioneers of modern shape theory and co-author of the book on "Shape and Shape Theory". She is well published in the general area of differential geometry and Statistics of Shapes and also in Financial Mathematics. She is currently professor of Mathematics at University of Nottingham, UK.

An Introduction to Network Science: History, Perspective, Statistical Research

Dr. Stanley Wasserman, Rudy Professor of Statistics and Psychology
Indiana University

Dr. Stanley Wasserman spoke on Friday, October 22nd, 2010 at 1:00PM in Engineering Building III, Room 2213

Data mining of network data often focuses on classification methods from machine learning, statistics, and pattern recognition perspectives. These techniques have been described by many, but many of these researchers are unaware of the rich history of classification and clustering techniques originating in social network analysis. The growth of rich social media, on-line communities, and collectively produced knowledge resources has greatly increased the need for good analytic techniques for social networks. We now have the opportunity to analyze social network data at unprecedented levels of scale and temporal resolution; this has led to a growing body of research at the intersection of the computing, statistics, and the social and behavioral sciences.

This talk discusses some of the current challenges in the analysis of large-scale social network data, focusing on the inference of social processes from data. The invasion of network science by computer scientists has produced much interesting, both good and bad, research. But it begins with a discussion of the history of network science.....

Stan Wasserman is Rudy Professor of Statistics and Psychology at Indiana University. An applied statistician, he joined the Departments of Sociology and Psychology in Bloomington in fall 2004. He also has an appointment in the Karl F. Schuessler Institute for Social Research. Prior to moving to Indiana, he held faculty positions at Carnegie-Mellon University, University of Minnesota, and University of Illinois, in the disciplines of Statistics, Psychology, and Sociology; in addition, at Illinois, he was a part-time faculty member in the Beckman Institute of Advanced Science and Technology, and has had visiting appointments at Columbia University and the University of Melbourne. In 2005, he helped create the new Department of Statistics in Bloomington, and became its first chair in 2006.

Wasserman is best known for his work on statistical models for social networks and for his text, co-authored with Katherine Faust, Social Network Analysis: Methods and Applications. His other books have been published by Sage Publications and Cambridge University Press. He has published widely in sociology, psychology, and statistics journals, and has been elected to a variety of leadership positions in the Classification Society of North America and the American Statistical Association. He teaches courses on applied statistics.

He is a fellow of the Royal Statistical Society and an honorary fellow of the American Statistical Association and the American Association for the Advancement of Science. He has been an Associate Editor of a variety of statistics and methodological journals (Psychometrika, Journal of the American Statistical Association, Sociological Methodology, to name a few), as well as the Book Review Editor of Chance. His research has been supported over the years by NSF, ONR, and NIMH.

He was educated at the University of Pennsylvania (receiving two degrees in 1973) and Harvard University (Ph.D., in Statistics, 1977).

From Millimeter to Terahertz Waves

Dr. John Scales, Professor of Physics
Colorado School of Mines

Dr. John Scales spoke on Friday, November 5th, 2010 at 1:00PM in Engineering Building III, Room 2213

Electromagnetic waves in the part of the spectrum between microwaves and the far-infrared can play an especially important role in science and technology. Here wavelengths are small enough to allow tightly collimated beams on the laboratory scale and yet complete control of the amplitude and phase. Since the wavelengths are a thousand times greater than optical, tolerances for quasi-optical components (mirrors, lenses, etc.) are correspondingly reduced. For example, meta-materials at optical frequencies may require elaborate nano-fabrication techniques, while at the millimeter scale, computer controlled milling may suffice. Many of the tricks that one can play with light (such as near-field scanning) can be done relatively easily with millimeter/submilleter waves. Finally, there are important scientific applications which are ideally suited to this range of frequencies, including Rydberg atoms, high magnetic fields, and the composition of the interstellar medium. In this talk I will give a survey of these ideas with specific examples drawn from recent work in my lab.

Dr. Scales obtained his BS in Physics from University of Delaware and his PhD degree in Physics from University of Colorado, Boulder. He joined Colorado School of Mines in 1992 where he is currently Professor of Physics. He has held two visiting Professorships in Paris, at the Institut de Physique du Globe where he investigated Inverse Problems theory and at Ecole supÃ©rieure de physique et de chimie industrielles (ESPCI) where he conducted research in wave chaos.

Digital Color Management: Getting the Colors Right

Dr. Michael J. Vrhel, Color Scientist
Artifex Software Inc.

Dr. Michael J. Vrhel spoke on Friday, November 19th, 2010 at 1:00PM in Engineering Building III, Room 2213

Everybody takes digital color images these days. They display them on the computer and often print them at a photo store or on a desktop printer. We create color graphics for display on the internet, for PowerPoint presentations and for printed documents. We expect the color of the reproduction to match the original. However, obtaining accurate color on a wide variety of devices is a complex task that requires understanding of the human visual system, image recording/reproduction device limitations and capabilities, estimation and optimization techniques, image and color standards, efficient programming methods and efficient ASIC designs. This seminar will introduce the design and engineering of color management systems for devices and software that record, manipulate and reproduce color images. The focus will be on real world problems the speaker has encountered and solved as well as open problems that still exist.

Michael Vrhel received his Ph.D. from NCSU in 1993. During his Ph.D. studies, Michael was an Eastman Kodak Fellow. From 1993 to 1996, Michael was a National Research Council, Research Associate at the National Institutes of Health. From 1997 to 2002, he was the Senior Scientist at Color Savvy Systems where he developed color device characterization software and low-cost color measuring instrumentation. From 2002 to 2005, he was a Distinguished Engineer at Conexant Systems, where he developed algorithms for halftoning, color correction, image compression, and resolution conversion within an embedded environment. From 2005 to 2006, he was an Imaging Scientist at TAK Imaging, where he continued work on embedded algorithms for high-quality output on inkjet and dye sublimation printers. In 2006, he was a founding member of Pagemark Technology, which is a provider of digital document technology. Currently, he is the Color Scientist at Artifex Software developing improved rendering methods for ghostscriptT. Dr. Vrhel is a coauthor with H. J. Trussell on Fundamentals of Digital Imaging, published by Cambridge University Press in 2008 and has over 40 publications in image and signal processing journals and conferences as well as several patents awarded or under review.

Topology in the 21st Century

Dr. Vin de Silva, Assistant Professor of Mathematics
Pomona College, California

Dr. Vin de Silva spoke on Friday, December 10th, 2010 at 1:00PM in Engineering Building III, Room 2213

In recent years, classical methods of algebraic topology have found increasing use in applications. The key ingredient for these applications is the persistent homology algorithm of Edelsbrunner, Letscher and Zomorodian (2000). I will discuss a few examples, from visual image statistics, sensor networks, and periodic dynamical systems.

Vin de Silva studied mathematics at Cambridge and Oxford, completing a doctorate in symplectic geometry under the supervision of Simon Donaldson. Since 2000, he has worked in applied topology, spending five years working in Gunnar Carlsson's research group at Stanford. His work with Josh Tenenbaum and John Langford on the isomap algorithm is widely cited to this day, and his collaboration with Robert Ghrist on sensor network topology was honored by a SciAm50 award in 2007. Vin is currently an assistant professor of mathematics at Pomona College, California, and holds a Digiteo Chair at INRIA Saclay Ile-de-France.

Information Aggregation in Complex Networks

Dr. Ali Jadbabaie, Skirkanich Associate Professor of Innovation
University of Pennsylvania

Dr. Ali Jadbabaie spoke on Friday, January 14th, 2011 at 1:00PM in Engineering Building III, Room 2213

Over the past few years there has been a rapidly growing interest in analysis, design and optimization of various types of collective behaviors in networked dynamic systems. Collective phenomena (such as flocking, schooling, rendezvous, synchronization, and formation flight) have been studied in a diverse set of disciplines, ranging from computer graphics and statistical physics to distributed computation, and from robotics and control theory to social sciences and economics. A common underlying goal in such studies is to understand the emergence of some global phenomena from local rules and interactions.

In this talk, I will expand on such developments and present and analyze new models of consensus and agreement in random networks as well as new algorithms for information aggregation tailored to opinions and beliefs in social networks. Specifically, I will present a model of social learning in which an agent acts as rational and Bayesian with respect to her own observations, but exhibits a bias towards the average belief of its neighbors to reflect the "network effect". When the underlying social network is strongly connected all agents reach consensus in their beliefs. Moreover, I will show that when each agent's observed signal is independent from others, agents will "learn" like a Bayesian who has access to global information, hence information is correctly aggregated.

Joint work with Pooya Molavi, Alireza Tahbaz-Salehi, Alvaro Sandroni and Victor Preciado.

Ali Jadbabaie received his BS degree (with High honors) in Electrical Engineering from Sharif University of Technology in 1995. After a brief period of working as a control engineer, he received a Master's degree in Electrical and Computer Engineering from the University of New Mexico, Albuquerque in 1997and a Ph.D. degree in Control and Dynamical Systems from California Institute of Technology in 2001. From July 2001-July 2002 he was a postdoctoral associate at the department of Electrical Engineering at Yale University. Since July 2002 he has been with the department of Electrical and Systems Engineering and GRASP Laboratory at the University of Pennsylvania, Philadelphia, PA, where he is currently the Skirkanich Associate Professor of Innovation. He is a recipient of various awards, including NSF Career, ONR Young Investigator, Best student paper award of the American Control Conference 2007 (as advisor), the O Hugo Schuck Best Paper award of the American Automatic Control Council (joint with his student), and the George S. Axelby Outstanding Paper Award of the IEEE Control Systems Society. His research is broadly in the interface of control theory and network science, specifically, analysis, design and optimization of networked dynamical systems with applications to sensor networks, multi-robot formation control, social aggregation and other collective phenomena.

FACTS (Flexible AC Transmission Systems) Machine for Smart Grid

Dr. Subhashish Bhattacharya, Assistant Professor, Department of Electrical and Computer Engineering
NC State University

Dr. Subhashish Bhattacharya spoke on Friday, January 28th, 2011 at 1:00PM in Engineering Building III, Room 2213

The FACTS was pioneered and all the initial research and development was done by Westinghouse R&D center (in Pittsburgh) funded by EPRI (Electric Power Research Institute) in the 1990s and in the last decade. This pioneering group not only developed the FACTS technology - also installed eight large FACTS systems (7 in the US and one in Korea) ranging from 40MVA to 320MVA.

Voltage Source Converters (VSC) has been applied for FACTS (Flexible AC Transmission Systems) applications, with rating from around 40 MVA to 200 MVA. Penalty for overall system losses for FACTS devices result in strict constraint on converter losses, and therefore, restrict the use of PWM (pulse-width modulated) converters. As a solution, development of "Harmonic Neutralized" (HN) VSC topologies are presented. Attention is focused on challenges and limitations of HN-VSC - such as converter control and magnetics saturation, and control strategies during a system fault. Solutions to these limitations of HN-VSC are proposed. Control challenges of HN-VSC for a successful FACTS installation - two 100 MVA VSCs for NYPA (New York Power Authority) Convertible Static Compensator (CSC), is used to demonstrate both pitfalls and solutions. Operational constraints and field results of all FACTS devices - STATCOM, SSSC, UPFC, and IPFC are discussed. Some new concepts to achieve cost-effectiveness and increased reliability of VSC based FACTS devices are also presented.

Subhashish Bhattacharya received his B.E. (Hons), M.E. and PhD degrees in Electrical Engineering from University of Roorkee (IIT-Roorkee), India in 1986, Indian Institute of Science (IISc), Bangalore, India in 1988, and University of Wisconsin-Madison in 2003, respectively. He worked in the FACTS (Flexible AC Transmission Systems) and Custom Power group at Westinghouse Science & Technology Center in Pittsburgh which later became part of Siemens Power Transmission & Distribution - FACTS and Power Quality Division, from 1998 to 2005. Since August 2005, he joined the Department of Electrical and Computer Engineering at North Carolina State University (NCSU) as an Assistant Professor, where he is also a faculty member of the FREEDM systems center NSF ERC (www.freedm.ncsu.edu) and Advanced Transportation Energy Center (ATEC - www.atec.ncsu.edu) at NCSU. His research interests are FACTS, Utility applications of power electronics such as custom power and power quality issues; active filters, high power converters, converter control techniques, integration of energy storage to the grid, and application of new power semiconductor devices such as SiC for converter topologies and solid-state transformer. He holds four U.S. patents and has published over 100 technical papers. He also worked with York International Corp. from 1994 - 1996 for commercialization of his active filter PhD research work for air-conditioner chiller application. He has been involved in several FACTS projects including the two 100 MVA Convertible Static Compensator (CSC) at New York Power Authority (NYPA).

Finite-dimensional variational inequalities: analysis, algorithms and applications

Dr. Shu Lu, Assistant Professor, Department of Statistics and Operations Research
University of North Carolina at Chapel Hill

Dr. Shu Lu spoke on Friday, February 11th, 2011 at 1:00PM in Engineering Building III, Room 2213

Given a set in a finite-dimensional Euclidean space, and a function from this Euclidean space to itself, a variational inequality is to find a point in the given set, so that the function value evaluated at this point is a normal vector to the set at this point. Variational inequalities provide a unified mathematical model

for a large number of problems. This can be a force equilibrium that describes the dynamics of mechanical equipment, or a traffic equilibrium that predicts transportation network flows, or an economic equilibrium that predicts commodity prices, sector activities and consumer consumptions. Variational inequalities are also closely related to nonlinear optimization problems. This talk will start with an overview of several aspects of variational inequalities, followed by a discussion of our understanding of their solution properties with respect to data perturbation.

Shu Lu received her B.S. (2000) and M.S. (2002) degrees in Civil Engineering from Tsinghua University, and then obtained M.S. degrees in Industrial Engineering (2006) and Mathematics (2006) and a Ph.D. in Industrial Engineering (2007) at the University of Wisconsin-Madison. She is an assistant professor at the Department of Statistics and Operations Research, the University of North Carolina at Chapel Hill. Her research interests are in the area of mathematical optimization, especially on variational inequalities and variational analysis.

Statistical Inference, Topology and Geometry

Dr. Sayan Mukherjee, Assistant Professor of Statistical and Computer Science
Institute for Genome Sciences & Policy

Dr. Sayan Mukherjee spoke on Friday, February 25th, 2011 at 1:00PM in Engineering Building III, Room 2213

This talk will focus on two problems at the interface of geometry and topology.

The first problem is inference of conditional dependencies given observations from a multivariate probability density. This is the problem of learning structure in a graphical model. We develop a parameterization of hypergraphs based on the geometry of points in d-dimensions. Informative prior distributions on hypergraphs are induced through this parameterization by priors on point configurations via spatial processes. The approach combines tools from computational geometry and topology with spatial processes and offers greater control on the distribution of graph features than Erdos-Renyi random graphs.

The second problem develops a topological approach to stratification for point cloud data. Given point cloud data drawn from a stratified space we provide an algorithm to infer which points belong to the same strata. First we define a multi-scale notion of a stratified space, giving stratifications over a set of resolution levels. We then use methods derived from kernel and cokernel persistent homology to cluster the data points into different strata, and we prove a result which guarantees the correctness of our clustering, given certain topological conditions.

Sayan Mukherjee is an Assistant Professor in the Departments of Statistical Science, Computer Science, Mathematics and the Institute for Genome Sciences & Policy. His research foci include geometry and topology in statistical inference, Bayesian models for high-dimensional data analysis, and applications in computational biology. He did his PhD from the AI Lab at MIT and was a PostDoctoral Fellow at The Broad Institute of MIT and Harvard.

Multiscale Geometric Methods for Noisy Point Clouds in High Dimensions

Dr. Mauro Maggioni, Assistant Professor in Mathematics and Computer Science
Duke University

Dr. Mauro Maggioni spoke on Friday, March 18th, 2011 at 1:00PM in Engineering Building III, Room 2213

We discuss techniques for the geometric multiscale analysis of intrinsically low-dimensional point clouds. We first show how such techniques may be used to estimate the intrinsic dimension of data sets, then discuss a novel geometric multiscale transform, based on what we call geometric wavelets, that leads to novel approximation schemes for point clouds, and dictionary learning methods for data sets. Finally, we apply similar techniques to model estimation when points are sampled from a measure supported on a union of an unknown number of unknown planes of unknown dimension.

Dr. Mauro Maggioni received the Ph.D. in Mathematics from the Washington University, St. Louis, in 2002. He then was a Gibbs Assistant Professor in Mathematics at Yale University, till 2006 when he moved to Duke University as an Assistant Professor in Mathematics and Computer Science. He works at the intersection between harmonic analysis, machine learning, graph theory, and signal processing.

Natural Language Processing in a Multilingual Setting

Dr. Sandra Kubler, Director of Computational Linguistics
Indiana University

Dr. Sandra Kubler spoke on Friday, March 25th, 2011 at 1:00PM in Engineering Building III, Room 2213

In the last two decades, Natural Language Processing (NLP) has almost exclusively worked on English. We know how to analyze English, how to produce it automatically, and how to translate into English. However, when we apply the methods developed for English to other languages, at best, the performance is significantly below the results for English, but in many cases, the methods cannot be applied at all. In this talk, I will give an overview of the research problems that researchers in NLP investigate at current. Then, I will focus on three problems, syntactic parsing, coreference resolution, and machine translation, and I will show the problems that we encounter if we use state-of-the-art methods for other languages.

Sandra Kubler is an Assistant Professor and the Director of Computational Linguistics in the Department of Linguistics at Indiana University. She holds a PhD in Computational Linguistics from the University of Tubingen and an MA from the University of Trier, both in Germany. Before she moved to Indiana, Kubler spent time at the University of Tubingen and the University of Duisburg. Her main research areas are dependency parsing, parsing for morphologically rich languages (mostly German), and machine learning for Computational Linguistics problems (e.g. for anaphora resolution or word sense disambiguation). She is interested in how to integrate linguistic information into machine-learning approaches to Computational Linguistics.

Bayesian Alignment of Unlabeled Marked Point Sets Using Random Fields

Dr. Ian Dryden, Professor, Department of Statistics
University of South Carolina

Dr. Ian Dryden spoke on Friday, April 15th, 2011 at 1:00PM in Engineering Building III, Room 2213

Statistical methodology is proposed for comparing unlabeled marked point sets, with an application to aligning molecules in chemoinformatics. Methods from statistical shape analysis are combined with techniques for predicting random fields in spatial statistics in order to define a suitable measure of similarity between two molecules. Bayesian modeling of the predicted field overlap between pairs of molecules is proposed, and posterior inference of the alignment is carried out using Markov chain Monte Carlo simulation. By representing the fields in reproducing kernel Hilbert spaces, the degree of molecule overlap can be computed without expensive numerical integration. Superimposing entire fields rather than the configuration matrices of point co--ordinates thereby avoids the problem that there is usually no clear one-to-one correspondence between the atoms. In addition mask parameters are introduced in the model, so that partial matching of molecules can be carried out. We also propose an adaptation of the generalized Procrustes analysis algorithm for the simultaneous alignment of multiple point sets. The methodology is applied to the dataset of 31 steroid molecules, where the relationship between shape and binding activity to the corticosteroid binding globulin receptor is explored. This is joint work with Irina Czogiel and Chris Brignell.

Ian L. Dryden received a PhD degree in statistics from the University of Leeds, UK in 1989. He has been a Professor in the Department of Statistics, University of South Carolina since 2009. Previous positions include Lecturer and Senior Lecturer at the University of Leeds, visiting assistant professor at the University of Chicago, and Professor of Statistics at the University of Nottingham, UK. His research interests include shape analysis, statistical image analysis, medical image analysis, spatial statistics, high-dimensional data analysis, and applications of statistics in biology, medicine and computer science. He was recently chair of the Research Section of the Royal Statistical Society.

Configuration Spaces of Hard Disks

Matthew Kahle, Assistant Professor
Ohio State University

Matthew Kahle spoke on Friday, April 29th, 2011 at 1:00PM in Engineering Building III, Room 2213

The hard spheres gas (or in two dimensions, hard disks) has long been studied in the context of statistical mechanics as a fundamental model of matter. Many computer simulations have suggested that there is a liquid-solid phase transition, but so far little is known mathematically. I will survey various recent results on understanding the underlying configuration spaces and changes in the topology as the radius of the disks varies.

This talk will include joint work with several others, including Gunnar Carlsson and Jackson Gorham, Yuliy Baryshnikov and Peter Bubenik, and Bob MacPherson.

Matthew Kahle completed his PhD in mathematics at the University of Washington in 2007. Since then he has held postdoctoral fellowships at Stanford and IAS, and he will be starting as an Assistant Professor at Ohio State this fall. He is broadly interested in interactions of topology and geometry with probability, statistical mechanics, and combinatorics

Algebraic Statistics

Seth Sullivant, Associate Professor, Mathematics
NC State University

Seth Sullivant spoke on Friday, August 26th, 2011 at 1:00PM in Engineering Building II, Room 1230

Algebraic statistics advocates polynomial algebra as a tool for addressing problems in statistics and its applications. This connection is based on the fact that most statistical models are defined either parametrically or implicitly via polynomial equations. The idea is summarized by the phrase "Statistical models are semi algebraic sets." I will try to illustrate this idea with two examples, the first coming from the analysis of contingency tables, and the second arising in computational biology. I will try to keep the algebraic and statistical prerequisites to an absolute minimum and keep the talk accessible to a broad audience.

Seth Sullivant received his Ph.D. in Mathematics in 2005 at the University of California, Berkeley, under the direction of Bernd Sturmfels. He joined the faculty at North Carolina State University in 2008 as an assistant professor of mathematics. In 2009 he received a Packard Foundation Fellowship for his research in algebraic statistics.

Fast, Automatic, Photo-realistic, 3D Modeling of Building Interiors

Avideh Zakhor, Professor, EECS
University of California, Berkley

Avideh Zakhor spoke on Friday, September 2nd, 2011 at 12:50PM in Engineering Building II, Room 1230

Automated 3D modeling of building interiors is useful in applications such as virtual reality and entertainment. In this talk, we develop an architecture and associated algorithms for fast, automatic, photo-realistic 3D models of building interiors. The central challenge of such a problem is to localize the acquisition device in GPS denied environments, while it is in motion, rather than collecting the data in a stop and go fashion. In the past, such acquisition devices have been placed on robots with wheels or human operated pushcarts, which would limit their use to planar environments. Our goal is to address the more difficult problem of localization and 3D modeling in more complex non-planar environments such as staircases, caves, or non-even surfaces. We propose a human operated backpack system made of a suite of sensors such as laser scanners, cameras, orientation measurement units (OMU)s which are used to both localize the backpack, and build the 3D geometry and texture of building interiors. We describe a number of localization algorithms based on merging laser, camera and OMU sensor information, and compare their performance using a high end IMU sensor which serves as the ground truth. Once the backpack is localized, a 3D point cloud can be generated and 3D meshing algorithms are applied to generate texture mapped 3D models. We show examples of resulting models for multiple floors of the electrical engineering building at U.C. Berkeley. Applications to image based rendering of 3D environments and mobile augmented reality will also be discussed.

Dr. Zakhor received her B.Sc. degree in Electrical Engineering, California Institute of Technology, 1983, a S.M. degree in Electrical Engineering and Computer Science from Massachusetts Institute of Technology, 1985, and a Ph.D. degree in Electrical Engineering and Computer Science, Massachusetts Institute of Technology, 1987. In 1994 she joined the faculty of EECS, UC Berkeley.

Honors and awards she has received include the General Motors Scholarship, 1982-3; Henry Ford Engineering Award, 1983; Hertz Fellowship, 1984-1988; Analog Devices Junior Faculty Development Award 1990-1995; IBM Junior Faculty Development Award 1990-1991; Presidential Young Investigator (PYI) Award, 1990; Office of Naval Research Young Investigator Award, 1992; IEEE Signal Processing Society Transactions Young Paper Award (with S. Hein) 1997; IEEE Circuits and Systems Society Video Technology Transactions Best Paper Award (with D. Taubman), 1997; IEEE Circuits and Systems Society Video Technology Transactions Best Paper Award (with R. Neff), 1999; International Conference on Image Processing best paper award (with R. Neff). 1999; Packet Video Workshop best paper award (with T. Ngyuen), 2002."

Bio-Inspired Cognition and Networks

Ali Sayed, Professor of Electrical Engineering
University of California

Ali Sayed spoke on Friday, September 23rd, 2011 at 1:00PM in Engineering Building II, Room 1230

Self-organized and complex patterns of behavior are common in many biological networks, where no single agent is in command and yet forms of self-organization and decentralized intelligence are evident. Examples include fish joining together in schools, birds flying in formation, bees swarming towards a new hive, and bacteria diffusing towards a nutrient source. While each individual agent in these biological networks is not capable of complex behavior, it is the combined coordination among multiple agents that leads to the manifestation of sophisticated order at the network level. The study of these phenomena opens up opportunities for collaborative research across several domains including economics, life sciences, biology, and information processing, in order to address and clarify several relevant questions such as: (a) how and why organized behavior arises at the group level from interactions among agents without central control? (b) What communication topologies enable the emergence of order at the higher level from interactions at the lower level? (c) How is information quantized during the diffusion of knowledge through the network? And (d) how does mobility influence the learning abilities of the agents and the network. Several disciplines are concerned in elucidating different aspects of these questions including evolutionary biology, animal behavior studies, physical biology, and even computer graphics. In the realm of signal processing, these questions motivate the need to study and develop decentralized strategies for information processing that are able to endow networks with real-time adaptation and learning abilities. Progress in this direction can help understand and reverse-engineer the decentralized intelligence and collective behavior that are commonly observed in socio, economic, and biological networks. Effective distributed information processing schemes can help provide effective guides to designing powerful cognitive networks in engineered systems. This presentation examines several patterns of decentralized intelligence in biological networks, and describes adaptation and learning strategies that are able to model and reproduce these kinds of behavior.

A. H. Sayed is Professor of Electrical Engineering at the University of California, Los Angeles, and Principal Investigator of the UCLA Adaptive Systems Laboratory (www.ee.ucla.edu/asl). He has published widely in the areas of adaptation and learning with over 350 articles and 5 books. His research interests span several fields including adaptive and cognitive networks, cooperative behavior, bio-inspired processing, distributed processing, and statistical signal processing.

Robust Topological Features For Deformation Invariant Image Matching

Dr. Edgar Lobaton, Assistant Professor, Department of Electrical and Computer Engineering
NC State University

Dr. Edgar Lobaton spoke on Friday, October 14th, 2011 at 12:50PM in Engineering Building II, Room 1230

Local photometric descriptors are a crucial low level component of numerous computer vision algorithms. In practice, these descriptors are constructed to be invariant to a class of transformations. However, the development of a descriptor that is simultaneously robust to noise and invariant under general deformation has proven difficult. In this paper, we introduce the Topological-Attributed Relational Graph (T-ARG), a new local photometric descriptor constructed from homology that is provably invariant to locally bounded deformation. This new robust topological descriptor is backed by a formal mathematical framework. We apply T-ARG to a set of benchmark images to evaluate its performance. Results indicate that T-ARG significantly outperforms traditional descriptors for noisy, deforming images.

Dr. Edgar J. Lobaton received the Ph.D. in electrical engineering and computer sciences from the University of California, Berkeley in 2009. He completed his B.S. degrees in mathematics and electrical engineering from Seattle University in 2004. Dr. Lobaton is currently an Assistant Professor in the Department of Electrical and Computer Engineering at North Carolina State University. His areas of research include computer vision, sensor networks, robotics and control. He works on applications ranging from surveillance using smart camera systems to motion planning for medical robotic applications. Prior to joining NCSU, he was awarded the 2009 Computer Innovation Fellows post-doctoral fellowship award and conducted research in the Department of Computer Science at the University of North Carolina at Chapel Hill. He was also engaged in research at Alcatel-Lucent Bell Labs in 2005 and 2009.

Greener Video Coding and Processing for the Mobile and Desktop Worlds

Dr. Ricardo L. de Queiroz, Full Professor, Computer Science Department
Universidade Estadual de Campinas, Brazil

Dr. Ricardo L. de Queiroz spoke on Friday, October 21st, 2011 at 12:50PM in Engineering Building II, Room 1230

Video encoding and transmission is discussed under the perspective of computation reduction and energy savings. Once the connection between computation intensity and energy consumption is established, we aim to reduce complexity and to save energy in mobile devices (in order to fit within the capabilities of low-powered chips and common batteries) and in desktops and servers (to reduce the electric bill) as well. We discuss software-based solutions using scalable-complexity algorithms for video encoding that try to optimize the encoding in a rate-distortion-complexity sense. The idea is to develop a cognitive coder that makes all decisions on its own, i.e. discovers the available bandwidth, available computer power and tolerable distortion, making the appropriate decisions. Rather than using compression speed, we can also measure the complexity as real consumed energy leading to RDE-optimized compression settings, which can halve the energy consumption incurring in very small performance penalties. Other methods using mixed-resolution-video approaches are also discussed. The applications encompass not only mobile devices but also video servers, transcoders, multiview video and free-viewpoint television.

Dr. Ricardo L. de Queiroz received the Engineer degree from Universidade de Brasilia, Brazil, in 1987, the M.Sc. degree from Universidade Estadual de Campinas, Brazil, in 1990, and the Ph.D. degree from The University of Texas at Arlington , in 1994, all in Electrical Engineering. In 1990-1991, he was with the DSP research group at Universidade de Brasilia, as a research associate. He joined Xerox Corp. in 1994, where he was a member of the research staff until 2002. In 2000-2001 he was also an Adjunct Faculty at the Rochester Institute of Technology. He joined the Electrical Engineering Department at Universidade de Brasilia in 2003. In 2010, he became a Full Professor at the Computer Science Department at Universidade de Brasilia. Dr. de Queiroz has published over 140 articles in Journals and conferences and contributed chapters to books as well. He also holds 46 issued patents. He is a past editor for the EURASIP Journal on Image and Video Processing, IEEE Signal Processing Letters, IEEE Transactions on Image Processing, and IEEE Transactions on Circuits and Systems for Video Technology. He has been appointed an IEEE Signal Processing Society Distinguished Lecturer for the 2011-2012 term. He is the General Chair of ISCAS'2011, MMSP'2009, and SBrT'2012. His research interests include image and video compression, multirate signal processing, and color imaging. Dr. de Queiroz is a Senior Member of IEEE, a member of the Brazilian Telecommunications Society and of the Brazilian Society of Television Engineers.

Multiple Uses of Correlation Filters for Biometrics

Vijay Kumar, Professor, Electrical and Computer Engineering Department
Carnegie Mellon University

Vijay Kumar spoke on Friday, November 4th, 2011 at 12:50PM in Engineering Building II, Room 1230

Determining the identity of a human is critical in many applications including access control and surveillance. Most current human authentication systems are password based making them susceptible to problems such as forgetting the password or passwords being stolen. One way to overcome these problems is to employ biometrics (e.g., fingerprints, face images, iris images, etc.) for authentication. Many biometric modalities produce images and biometric verification (1:1 matching) and identification (1:N matching) involves matching these images. Many conventional biometric image matching methods are based on segmenting the regions of interest, extracting the features in the image domain and applying classifiers to separate these features. However, there are advantages to using signal processing methods that work in the spatial frequency domain. Correlation filters are one class of frequency domain-based methods that offer benefits such as shift-invariance (i.e., the object of interest can be off-center), no need for segmentation, graceful degradation and closed-form solutions. This talk will provide an overview of correlation filter design approaches and their applications in biometrics including matching patterns, image alignment, providing information for graphical models, creating cancellable biometrics and biometric encryption.

Prof. B.V.K. Vijaya Kumar received his Ph.D. in Electrical Engineering from Carnegie Mellon University (CMU), Pittsburgh and since 1982, he has been a faculty member in the Electrical and Computer Engineering (ECE) Department at CMU where he is now a Professor and the Associate Dean for the College of Engineering. He served as the Associate Head of the ECE Department and also as its Acting Department Head. Professor Kumar's research interests include Pattern Recognition (for automatic target recognition and biometrics applications) and Coding and Signal Processing for Data Storage Systems and for Digital Communications. He has authored or co-authored over 500 technical papers, fifteen book chapters and one book entitled Correlation Pattern Recognition. He served as a Topical Editor for Applied Optics and as an Associate Editor of IEEE Trans. Information Forensics and Security. Professor Kumar is a Fellow of IEEE, a Fellow of SPIE, a Fellow of Optical Society of America (OSA) and a Fellow of the International Association of Pattern Recognition (IAPR).

Compressive Sensing-Based MIMO Radar

Athina Petropulu, Chair of the Electrical and Computer Engineering Department
Rutgers University

Athina Petropulu spoke on Wednesday, November 9th, 2011 at 12:50PM in Engineering Building II, Room 1230

The talk will present a new approach for multiple-input multiple-output (MIMO) radar using compressive sensing (CS). CS-based MIMO radar exploit the sparsity of targets in the target space to achieve the same localization performance as traditional MIMO radar but with significantly fewer measurements. Each receive node of the MIMO radar compresses the received signal via a linear transformation, referred to as measurement matrix. The compressively obtained samples are subsequently forwarded to a fusion center, where an optimization problem is formulated and solved for target information. The measurement matrix plays an important role in CS recovery algorithms. The talk will also discuss optimal design of the measurement matrix and also reduced complexity suboptimal constructions for it.

Athina P. Petropulu received the Diploma in Electrical Engineering from the National Technical University of Athens, Greece in 1986, the M.Sc. degree in Electrical and Computer Engineering in 1988 and the Ph.D. degree in Electrical and Computer Engineering in 1991, both from Northeastern University, Boston, MA. Between 1992-2010 she was faculty at the Department of Electrical and Computer Engineering at Drexel University. Since 2010, she is Professor and Chair of the Electrical and Computer Engineering Department at Rutgers, The State University of New Jersey. She has held visiting appointments at SUPELEC in France and at Princeton University. Dr. Petropulu's research interests span the area of statistical signal processing, wireless communications, signal processing in networking and biomedical signal processing. She is the recipient of the 1995 Presidential Faculty Fellow Award in Electrical Engineering given by NSF and the White House. She is the co-author (with C.L. Nikias) of the textbook entitled, "Higher-Order Spectra Analysis: A Nonlinear Signal Processing Framework," (Englewood Cliffs, NJ: Prentice-Hall, Inc., 1993).

Dr. Petropulu is Fellow of IEEE. She is currently serving as Editor-in-Chief of the IEEE Transactions on Signal Processing (2009-2011). She was IEEE Signal Processing Society Vice President-Conferences (2006-2008), and member-at-large of the IEEE Signal Processing Board of Governors. She has served as an Associate Editor for the IEEE Transactions on Signal Processing the IEEE Signal Processing Letters, was member of the editorial board of the IEEE Signal Processing Magazine and the EURASIP Journal on Wireless Communications and Networking. She was the General Chair of the 2005 International Conference on Acoustics Speech and Signal Processing (ICASSP-05), Philadelphia PA.

She is co-recipient of the 2005 IEEE Signal Processing Magazine Best Paper Award.

Screening For Connections and Hubs In Large Scale Correlation Graphs

Alfred Hero, R. Jamison and Betty Williams Professor of Engineering
University of Michigan

Alfred Hero spoke on Friday, December 2nd, 2011 at 12:50PM in Engineering Building II, Room 1230

Correlation graphs arise in many areas of engineering, social science, and natural science where they are used to explore the dependency structure. In this talk we will present recent results on screening correlation graphs for connectivity patterns when the graph is constructed from sample correlations with a small number of observations. As the number of variables increases screening for connected variables becomes futile due to a high dimensional phase transition phenomenon: with high probability most variables will have large sample correlations even when there is no correlation present. We apply our framework to the problem of hub discovery in correlation and partial correlation (concentration) graphs. We illustrate our correlation screening framework in computational biology and, in particular, for discovery of influential variables in gene regulation networks. This is joint work with Bala Rajaratnam at Stanford University.

Alfred Hero is the R. Jamison and Betty Williams Professor of Engineering at the University of Michigan. He also holds the position of Digiteo Chair at the Digiteo Research Institute in France. At the University of Michigan his primary appointment is in the Department of Electrical Engineering and Computer Science (EECS) and he has secondary appointments in the Department of Biomedical Engineering and the Department of Statistics. He is also affiliated with the UM Program in Biomedical Science (PIBS) and the UM Graduate Program in Applied and Interdisciplinary Mathematics (AIM).

At the boundaries of high-frequency analog & RF ICs: Speed, energy and uncertainty

David Ricketts, Harvard Innovation Fellow, School of Engineering & Applied Science
Harvard University

David Ricketts spoke on Friday, December 9th, 2011 at 12:50PM in Monteith Research Center (MRC) 136

In integrated circuits, the analog domain represents the interface between the physical world and the modern digital age. Because of this, many of the boundaries of performance, such as speed, energy, efficiency, linearity, etc., are a direct result of physical limitations, such as noise, power, size and fundamental device operation. In this talk I will discuss our approach to address several of the important limitations in modern analog and RF ICs through the development of novel circuits and new passive and active devices. I will illustrate our work through two specific research projects. The first aims to significantly increase the speed, power output and efficiency of RF power amplifiers (PA). Current state-of-the-art Si PAs above 20 GHz suffer from low power-added-efficiency (PAE) and output power, typically < 20% and < 0.5W. I will present our work on developing high PAE (30% - 50%), high power PAs (> 1W) above 45 GHz using SiGe and 45 nm CMOS, optimized topologies, active cascodes and novel power combiners. The second project aims to realize high effective number of bits (ENOB) ADCs. At very high sampling rates (40 GS/s) and high resolutions (> 10 bits), clock degradation and jitter represents some of the fundamental roadblocks to achieving high ENOB for frequencies close to Nyquist. In this research I am examining clock skew, clock slope and distribution, and clock jitter and their impact on high-speed, interleaved ADCs. I will discuss our efforts to understand these fundamental limitations and some ideas on how to overcome them to achieve ADCs with ENOB > 5 bits at speeds of 40 GS/s and ENOB > 10 bits at 1GS/s. In addition to our work on high-speed analog and RF, I will briefly discuss some of the other research we are pursuing at the interface of physical world and circuits: microrobotics, nanoelectronic devices, and magnetoquasistatic wireless power and position tracking.

David S. Ricketts received the PhD from Harvard University and is an Assistant Professor of ECE and MSE (courtesy) at Carnegie Mellon University. Before joining academia, Professor Ricketts spent 8 years in industry developing over 40 intergrated circuits in mixed-signal, RF and power management applications. Prof. Ricketts' research crosses the fields of device physics, material science and circuit design. His work has appeared in Nature, Proc. IEEE and in numerous other IEEE conferences and journals and he has authored two books: Electrical Solitons: Theory, Design and Applications and The Designerâ��s Guide to Jitter in Ring Oscillators. He is the recipient of the NSF CAREER award, the DARPA Young Faculty Award and the George Tallman Ladd research award at Carnegie Mellon. In addition to his technical research, Prof. Ricketts investigates the role of the scientist and engineer in creating breakthrough innovations and has co-developed several courses on innovation and creativity at Harvard and Carnegie Mellon. He is currently a Harvard Innovation Fellow in the School of Engineering and Applied Science at Harvard University and was a 2009 Wimmer Teaching Fellow at Carnegie Mellon.

A Weight-Based View of Approximate Inference In Graphical Models

Alexander Ihler, Assistant Professor, Department of Computer Science
University of California, Irvine

Alexander Ihler spoke on Friday, January 20th, 2012 at 12:50PM in Engineering Building II, Room 1230

Graphical models provide a powerful framework for reasoning about complex models with uncertainty. "Inference" in a graphical model refers generically to answering probabilistic queries such as computing probabilities or finding optima. Types of inference tasks include max-inference (finding optimal configurations), sum-inference (calculating marginal probabilities or the probability of evidence), and mixed-inference (problems with both max and sum, for example so-called marginal MAP problems). Since all these tasks are NP-hard in general, approximation methods -- especially those that provide bounds -- are of great interest, and variational algorithms such as belief propagation and its variants have emerged as particularly powerful approaches. In this talk I will discuss a general framework that unifies many variational approaches, in which different inference tasks and algorithms are achieved by selecting different "weights" in the algorithm. As one consequence, we will show that this framework leads directly to novel and efficient approximation algorithms for mixed-inference problems, known to be the most difficult of the three tasks.

Alexander Ihler is an Assistant Professor in the Department of Computer Science at the University of California, Irvine. He received his Ph.D. from MIT in 2005 and B.S. from Caltech in 1998. His research focuses on machine learning, graphical models, and algorithms for exact and approximate inference, with applications to areas including sensor networks, computer vision, data mining, and computational biology.

Skewed functional processes and their applications

Dr. Ana-Maria Staicu, Assistant Professor, Statistics Department
North Carolina State University

Dr. Ana-Maria Staicu spoke on Friday, February 3rd, 2012 at 12:50PM in Engineering Building II, Room 1230

We introduce a novel class of models for functional data exhibiting skewness or other shape characteristics that vary with spatial location. Such data are not envisaged by the current approaches to model functional data, due to the lack of Gaussian â�� like features. Our methodology allows modeling the pointwise quantiles, has interpretability advantages and is computationally feasible. The methods were motivated by and are illustrated with a state-of-the-art study of neuronal tracts in multiple sclerosis patients and healthy controls.

Ana-Maria Staicu [styku] received her Ph.D. in Statistics from University of Toronto in 2007, under the direction of Nancy Reid. She did postdoctoral studies at the University of Bristol, UK, and has joined the Department of Statistics at NC State University since 2009. Her research interests include functional data analysis, likelihood methods, applications in biostatistics.

Reformation-Based Approaches to Query Optimization

Dr. Rada Chirkova, Associate Professor, Computer Science Department
North Carolina State University

Dr. Rada Chirkova spoke on Friday, February 17th, 2012 at 12:50PM in Engineering Building II, Room 1230

In relational database systems, users can query the stored tables (relations) by specifying, in the query language SQL, what they want to get in query answers. At the same time, a SQL query does not specify any plan for constructing the query answer. As a result, relational database-management systems have a module called "query optimizer"; the goal of this module is to find plans, which must be as efficient as possible, for executing user queries on large stored data. In this talk, we overview the problem of forming the search space of alternative query plans and outline formal solutions to the problem. The results presented in the talk can be used in query optimizers to answer complex queries efficiently on large data.

Rada Chirkova is an associate professor at the Computer Science Department at North Carolina State University. She received the B.Sc. and M.Sc. degrees, both in applied mathematics, from Moscow State University, Russia, and the Ph.D. degree in computer science in 2002 from Stanford University. Her research interests are in databases, with a focus on efficient query processing. She is a recipient of the US National Science Foundation Career award. She has served on the program committees of leading database conferences, including ACM SIGMOD, VLDB, ICDE, and PODS.

Super-Turing Computation

Dr. Hava Siegelmann, Associate Professor of Computer Science and Neuroscience
University of Massachusetts Amherst

Dr. Hava Siegelmann spoke on Friday, February 24th, 2012 at 12:50PM in Engineering Building II, Room 1230

Super-Turing Computation (STC) is a vastly different human brain analog computational alternative. The real world is infinitely detailed on many levels of abstraction like analog real numbers; to deal with this overwhelming, constantly changing ocean of data, the brain must by necessity operate in a highly efficient and adaptive manner: Efficiency and flexibility characterize Super-Turing (ST) computational processes. ST computation is not Turing computation on steroids; rather, the two methods diverge sharply: Turing computation is easy to program and its widespread use testifies to its utility, but the method suffers from its inability to modify its program. ST computation is exemplified by its flexibility, reliance on interactivity with input, and its foundational ability to learn and to focus on goal-directed data processing.

While I originally saw Super-Turing as a brain-inspired superior computational model, I've come to realize that the same qualities of efficiency, learning, increasing precision by need and continuous dynamics - underlie much of the natural world. Perhaps the world, through billions of years of evolution, arrived at the same efficient Super-Turing method I uncovered in an attempt to construct a more efficient and more capable computational method.

Hava T. SIEGELMANN is an associate professor of Computer Science and Neuroscience at the University of Massachusetts at Amherst, and the director of the BINDS (Biologically Inspired Neural and Dynamical Systems) laboratory. Dr. Siegelmann's research focuses on mathematical modeling of biological systems with particular interest in memory, epigenetics, cellular development and disease evolution. Her research into biologically inspired memory and artificial intelligence has led to machine systems, which are more autonomous: capable of learning, tracking, clustering, associating, and inferring and are more robust and capable of operating in real-world environments. She introduced the highly utile Support Vector Clustering algorithm with Vladimir Vapnik and colleagues. Siegelmann's seminal Turing machine equivalence of recurrent neural networks theorem and the super-Turing theory, which greatly impacted current thinking on computation, have found new utility in her work on machine memory reconsolidation and intelligent cellular function. Her work is often interdisciplinary, and combines methods from the fields of Complexity Science, Networks Theory, Dynamical Systems, Artificial Intelligence and Machine Learning. Dynamical Health is Siegelmann's recent thesis stating that an unbalanced dynamic is the cause of most systemic disorders, that returning the system to balance is extremely beneficial to healing and further, that it is too limiting to focus only on primary causes, when any treatment that returns balance is sufficient for healing. Modeling these systems mathematically provides a means of exploring many possible solutions, which can then be translated to actual treatment. Her recent system biology studies include genetic networks, circadian system, memory reconsolidation, miRNA, cancer, and now addiction. She remains active in supporting young researchers and encouraging minorities and women to enter and advance in the sciences.

Empirical Mode Decompositions, From basics to recent results

Patrick Flandrin, Research Director
Laboratoire de Physique, Eciole Normale Supérieure de Lyon, France

Patrick Flandrin spoke on Friday, March 16th, 2012 at 12:50PM in Engineering Building II, Room 1230

Decomposing an observed signal into a combination of amplitude and frequency modulated orthogonal components is an ill-posed problem for which numerous solutions have been proposed in the past, based on various constraints. Amongst the most recent ones stand the empirical mode decomposition (EMD), whose conceptual simplicity and effectiveness in a number of applications make it appealing despite its merely empirical grounds. The purpose of this lecture is to give a comprehensive overview of EMD, from its original formulation to several extensions and/or variations that have been recently proposed, and to highlight pros and cons of the method.

Patrick Flandrin (F) received the engineer degree from ICPI Lyon, France, in 1978, and the Doct.-Ing. and Docteur d'Etat degrees from INP Grenoble, France, in 1982 and 1987, respectively. He joined CNRS in 1982, where he is currently a Research Director. Since 1991, he has been with the Signals, Systems, and Physics Group, Physics Department, Ecole Normale SupÃ©rieure de Lyon, France.

Prof. Flandrin has been a major contributor to the theory of (bilinear) Time-Frequency representations and non-stationary signal analysis. He played a major role in the developments of the wavelet theory and the analysis of fractional Brownian motion. Recently, he opened a new research direction studying the Empirical Mode Decomposition and revisiting stationarity with significant contributions on stationarity tests.

Prof. Flandrin is author of the book titled, Time-Frequency/Time-Scale Analysis and has authored more than 250 journal and conference proceeding research articles.

Prof. Flandrin received several research awards including Philip Morris Prize in Mathematics (1991); SPIE Wavelet Pioneer Award (2001); "Prix Michel Monpetit" from the French Academy of Sciences (2001); and Silver Medal from CNRS (2010).

Revitalizing the Power Grid Needs, Benefits and Advancements

Dr. Damir Novosel, President
Quanta Technology

Dr. Damir Novosel spoke on Friday, March 23rd, 2012 at 12:50PM in Engineering Building II, Room 1230

In last few years, sense of urgency has been brought to all energy issues, including the electric power grid. Reliable grid operation is critical to society and oil dependency and environmental concerns drive the power industry. Electrical utility industry is making the transition to new infrastructure with benefits of improving the performance of electric utility systems and addressing the energy needs of society, such as improved efficiency and utilization, renewable energy and electrical vehicle integration, demand response, power quality and reduced maintenance cost. The above requires system and equipment reinforcement, improved integrated system planning and operation, and increased automation. This complex infrastructure requires use of the advanced technology or â��Smart Gridâ��.
This seminar addresses following topics:
? Emerging Industry Trends and Issues in Advancing and Shaping the Grid
? Innovative Smart Grid Technologies
? Advancements in Transmission Research
? Workforce Needs for the 21st Century
The global topic of development and deployment of a â��smarterâ�� electricity grid has been at the forefront of industry initiatives and investments around the world. Advanced monitoring, protection, and control technologies enable implementation of â��smarterâ�� electrical grids to realize the needs of the electricity users for sustainable energy delivery and enhanced power system performance. Transmission system aspects are analyzed, including preventing system-wide outages using Wide Area Measurement, Protection, and Control (WAMPAC) technology such as synchronized measurements. Benefits of using WAMPAC and latest research advancements in System Voltage Management are described in more detail.

Dr. Damir Novosel is President of Quanta Technology. Prior to joining Quanta Technology, Damir was President of KEMA T&D Consulting in the US. He has also held various positions in ABB, including Vice President of global development and product management for automation products. Damir has been adjunct professor at North Carolina State University since 1997 and thought at Mississippi State University (1991 -1992).
His work in automation and power system monitoring, protection, and control earned him international recognition and was elected IEEE Fellow in 2003. Damir holds 16 US and international patents and has published 112 articles in Refereed Journals and Conference Proceedings. He received the IEEE PES 2011 Prize Paper Award. He contributed to McGraw-Hill 2006 Yearbook of Science and Springer 2012 Encyclopedia of Sustainability Science and Technology. Damir led or contributed to 20 IEEE and CIGRE guides, standards, and reports; thought a number of international courses and tutorials; and was a keynote speaker and panelist at numerous international conferences and workshops.
He is presently Chair of the IEEE PES Technical Council, IEEE PES VP of Technology, member of the CIGRE Executive Committee, and has been chairing Performance Requirement Task Team for the North American Synchro-Phasor Initiative (NASPI) since 2004. Damir also chaired the PES Fellows committee. Dr. Novosel holds PhD and MSc degrees in electrical engineering from Mississippi State University (where he was a Fulbright scholar) and University of Zagreb, Croatia, respectively.

Controlling Epitaxial Graphene Growth

Dr. D. Kurt Gaskill, Senior Scientist
Advanced SiC Epitaxial Research Laboratory, U.S. Naval Research Laboratory, Washington, DC 20375

Dr. D. Kurt Gaskill spoke on Friday, April 6th, 2012 at 12:50PM in Engineering Building II, Room 1230

Graphene, discovered less than 7 years ago and subject of the most recent Nobel Prize in Physics, is the thinnest known substance in the universe and has properties superior to all other materials known to man. For this reason, it has rapidly risen as a leading candidate material for transparent conductors; ultra-strong membranes for electron microscopy; touch screen and flexible electronics; atom-sensitive balances; individual gas molecule sensors; and low power, high frequency mm-wave/THz receivers for sensing applications. Recently, there has been tremendous progress in the fabrication of epitaxial graphene (EG) RF devices [1]. Understanding the initial steps of graphene growth is paramount to future EG growth control strategies for continued device progress. In this regard, we present recent results in two areas of EG synthesis: graphene "island" formation on (000-1) [C-face] 6H-SiC and single layer graphene growth on (0001) [Si-face] 4H-SiC step-free mesas (SFMs).
Through control of temperature and Ar pressure, graphene epitaxy can be slowed, resulting in local areas of growth on the C-face of SiC [2]. These "islands" are thought to represent early stages in graphene growth. In all cases examined, the islands nucleated from threading screw dislocations associated with the substrate. We used optical and scanning electron microscopy, electron channeling contrast imaging and Raman spectroscopy to take "snapshots" of the growth process from island to complete film.
To aid in understanding EG synthesis on the Si-face of SiC without the impact of substrate defects, we investigated its growth on SFMs. SFMs were formed by a kinetically-controlled lateral step-flow SiC growth process at 15800C on (0001) 4H-SiC substrates patterned with mesas [3]. When threading screw dislocations are not present on a mesa, the SiC growth process results in atomically flat surfaces. Subsequently, EG was grown in a 100 mbar Ar ambient at 1620Â°C on an array of SFMs with side lengths ranging from 40 ?m to 200 ?m. For short growth times, partial graphene coverage of SFMs was observed suggesting a growth mechanism limited, in part, by C surface diffusion. For long growth times, complete EG mesa coverage was established and the step bunching morphology typically observed on conventional basal plane substrates was not found. In addition, mesa graphene was found to have other properties that differ substantially from EG grown on conventional basal plane substrates, e.g., Raman spectroscopy implied that bilayer graphene can be naturally formed.

Dr. D. Kurt Gaskill (publications > 140, patents = 5) did his graduate work in hyperfine interactions in liquid semiconductor alloys (Physics, Oregon State U. 1984). He became a National Research Council Postdoctoral Fellow at NRL in 1984 and performed research on the growth of epitaxial GaN using alternative chemistries. He became a member of NRL's technical staff in 1987 and has conducted research in the epitaxial growth, in-situ characterization of growth, and electrical and spectroscopic characterization of various III-V semiconductors. In the last few years, he has lead the SiC epitaxial research effort focused upon alleviating the problems of certain extended and point defects in power electronics. In addition, he leads the epitaxial graphene research effort and is currently the NRL PI for the DARPA CERA Phase II Program.

The Impact of Time Delays in Network Synchronization in a Noisy Environment

Gyorgy Korniss, Professor, Department of Physics and The Social and Cognitive Networks Academic Research Center
Rensselaer Polytechnic Institute

Gyorgy Korniss spoke on Friday, April 13th, 2012 at 12:50PM in Engineering Building II, Room 1230

Coordinating, distributing, and balancing resources in networks is a complex task and it is very sensitive to time delays. To understand and manage the collective response in these coupled interacting systems, one must understand the interplay of stochastic effects, network connections, and time delays. In synchronization and coordination problems in coupled interacting systems individual units attempt to adjust their local state variables (e.g., pace, orientation, load) in a decentralized fashion. They interact or communicate only with their local neighbors in the network, often with explicit or implicit intention to improve global performance. Applications of the corresponding models range from physics, biology, computer science to control theory.

I will discuss the effects of nonzero time delays in stochastic synchronization problems with linear couplings in an arbitrary network. Further, by constructing the scaling theory of the underlying fluctuations, we establish the absolute limit of synchronization efficiency in a noisy environment with uniform time delays, i.e., the minimum attainable value of the width of the synchronization landscape. These results have also strong implications for optimization and trade-offs in network synchronization with delays.

Prof. Gyorgy Korniss received his MS in Physics at Eotvos University, Budapest in 1993 and his Ph.D. in Physics at Virginia Tech in 1997. His research background is statistical physics and interacting and agent-based systems. He was a postodoc at the Supercomputer Computations Research Institute, Florida State University between 1997-2000. He has been in the Department Physics at RPI since 2000, where he has been an Associate Professor since 2006. His current research focuses on opinion dynamics and influencing in social networks, transport and flow in complex networks, and synchronization and coordination in coupled stochastic systems. More information and recent publications can be found at: http://www.rpi.edu/~korniss/

Design and Performance of Adaptive Systems, Based on Evolutionary Optimization Strategies

Dr. W. K. Jenkins, Professor of Electrical Engineering
The Pennsylvania State University

Dr. W. K. Jenkins spoke on Friday, April 20th, 2012 at 12:50PM in Engineering Building II, Room 1230

While the theory and design of linear adaptive filters based on FIR filter structures is well developed and widely applied in practice, the same situation is not true for linear IIR or for nonlinear adaptive filters in general. The latter situation exists because both linear IIR structures and nonlinear structures sometimes produce multi-modal error surfaces on which stochastic gradient optimization strategies fail to reach the global minimum. This seminar begins with a concise review of state-of-the-art techniques in linear adaptive filtering, and then develops the need for nonlinear adaptive filters in applications such as nonlinear echo cancellation, nonlinear channel equalization, and acoustic channel identification. Several basic nonlinear adaptive structures will be discussed, including Volterra models, neural network models, and series cascade modular structures. Then three important evolutionary optimization algorithms will be introduced as potentially useful algorithms to deal with multimodal error surfaces. The three evolutionary algorithms to be considered are the simulated annealing, genetic, and particle swarm optimization (PSO) algorithms. Particular emphasis will be placed on the PSO techniques because they have not received much previous attention for adaptive filtering.

W. Kenneth Jenkins received the B.S.E.E. degree from Lehigh University and the M.S.E.E. and Ph.D. degrees from Purdue University. From 1974 to 1977 he was a Research Scientist Associate in the Communication Sciences Laboratory at the Lockheed Research Laboratory, Palo Alto, CA. In 1977 he joined the University of Illinois at Urbana-Champaign where he was a faculty member in Electrical and Computer Engineering from 1977 until 1999. From 1986-1999 Dr. Jenkins was the Director of the Coordinated Science Laboratory. From 1999 through 2011 he served Professor and Head of Electrical Engineering at Penn State University.

Dr. Jenkins' current research interests include fault tolerant DSP for highly scaled VLSI systems, adaptive signal processing, multidimensional array processing, computer imaging, bio-inspired optimization algorithms for intelligent signal processing, and fault tolerant digital signal processing. He co-authored the book Advanced Concepts in Adaptive Signal Processing, published by Kluwer in 1996. He is a past Associate Editor for the IEEE Transaction on Circuits and Systems, and a past President (1985) of the CAS Society. He served as General Chairman of the 1988 Midwest Symposium on Circuits and Systems and as the General Chairman of the Thirty Second Annual Asilomar Conference on Signals and Systems. From 2002 to 2007 he served on the Board of Directors of the Electrical and Computer Engineering Department Heads Association (ECEDHA) and as President of ECEDHA in 2005.

Dr. Jenkins is a Fellow of the IEEE and a recipient of the 1990 Distinguished Service Award of the IEEE Circuits and Systems Society. In 2000 he received a Golden Jubilee Medal from the IEEE Circuits and Systems Society and a 2000 Millennium Award from the IEEE. In 2000 was named a co-winner of the 2000 International Award of the George Montefiore Foundation (Belgium) for outstanding career contributions to the field of electrical engineering and electrical science, in 2002 he was awarded the Shaler Area High School Distinguished Alumnus Award, and in 2007 he was honored with an IEEE Midwest Symposium on Circuits and Systems 50th Anniversary Award.

Applied Topology and Matrix Methods

Dr. Anil Hirani, Applied Mathematician
Dept. of Computer Science - University of Illinois at Urbana-Champaign

Dr. Anil Hirani spoke on Friday, September 7th, 2012 at 12:50PM in Engineering Building II, Room 1230

Applied topology is a relatively new field. This talk is a survey of matrix based methods which extend its reach in new directions. (1) Given a sparse set of pairwise comparisons (between objects, sports teams, movies, candidates, etc.) a global ranking can be computed as a least squares problem. Digging deeper, newer applications of such data become possible with Hodge decomposition. I will show how to do this efficiently on many types of graphs using various matrix methods. One application will be to rank NCAA Men's Basketball teams. One surprise is the failure of a technique which is otherwise quite popular in traditional scientific computing. (2) Harmonic forms are one piece of Hodge decomposition. These have been widely used in computer graphics for texture mapping and vector field design. I will show their use in locating holes in idealized sensor networks by solving certain linear systems. Then I'll show how to use eigenvector and least squares methods to find harmonic forms on meshes. These can then be used to solve vector elliptic partial differential equations in topologically interesting domains. (3) The above problems are both related to L2 (2-norm) minimization. In contrast L1 (1-norm) minimization has sometimes been hailed as the technique to supplant least squares for this century's problems. I will show how the use of 1-norm transforms two NP-hard topological problems into polynomial time solvable problems.

The Road to Terabit Satellites: Science-Fiction or Science?

Claudio Sacchi, Assistant Professor
University of Trento, Dept. of Information Engineering & Computer Science, Disi, Italy

Claudio Sacchi spoke on Friday, September 14th, 2012 at 12:50PM in Engineering Building II, Room 1230

Since the early and visionary work published by A.C. Clarke on the journal ?Wireless World? in 1945, and for a long time, satellites were regarded as the only mean able at guaranteeing the ?global seamless coverage? over the terrestrial globe. Satellites allowed the worldwide TV broadcast and the intercontinental telephony service since mid of ?60s. Moreover, since almost 35 years, satellites enabled the global localization service (GPS) first to military and then to civil users. But, a lot of year has passed and the telecommunication market has become more and more aggressive and competitive. The recent enormous development of terrestrial networking, characterized by wired and wireless segments able at bearing broadband connectivity almost everywhere, trends to take away market shares from the satellites.

In this last ten years, the role of satellites in the commercial ICT panorama has been newly discussed. There is a general agreement about the fact that there is still room for satellite communications in the global TLC market. However, in order to compete with terrestrial networks, satellite operators and manufacturers should drastically decrease the cost per transmitted bit/sec. that is currently still too high. The simplest way to decrease the cost is to increase satellite throughput by exploiting larger frequency bandwidths without significantly increasing the power budget. The SATCOM research individuated some ?core? technologies that are currently available and may allow increasing the satellite link capacity at affordable cost: multibeam coverage with frequency reuse, use of high-spectrum efficiency waveforms, and use of higher frequency bands in the EHF domain, diversity combining, efficiency radio resource management and novel networking paradigms like Delay-Tolerant Networks (DTN).

Some very recent papers are speaking about ?multi-gigahertz? satellites or ?terabit? satellites. These terms are really exciting. But, as wisely entitled by J.D. Gayrard in his paper ?Terabit Satellite: Myth or Reality?? (published in SPACOMM Conference 2009), we should clearly separate the mythology from the reality or, in other words, science-fiction from science (even though, we should always take in mind that the first paper dealing with satellite communications was published by a science-fiction writer).

The seminar will show to the audience the latest technological developments about broadband satellite technologies, trying to insert them in the framework of the ?terabit? perspective. The accent will be posed in particular on efficient transmission, coding and multiple access management, considering also the perspective of near-future EHF domain exploitation with on-going research activities and some experimental activities (like Q-V band ALPHASAT ESA mission) that are already in their operative phase.

Deep Learning of Invariant Feature Hierarchies

Yann LeCun, Silver Professor of Computer Science and Neural Science
Courant Institute of Mathematical Sciences and Center for Neural Science, New York University

Yann LeCun spoke on Friday, September 21st, 2012 at 12:50PM in Engineering Building II, Room 1230

Intelligent perceptual tasks such as vision and audition require the construction of good internal representations. Machine Learning has been very successful for producing classifiers, but the next big challenge for ML, computer vision, and computational neuroscience is to devise learning algorithms that can learn features and internal representations automatically.

Theoretical and empirical evidence suggest that the perceptual world is best represented by a multi-stage hierarchy in which features in successive stages are increasingly global, invariant, and abstract. An important question is to devise "deep learning" methods for multi-stage architecture than can automatically learn invariant feature hierarchies from labeled and unlabeled data.

A number of unsupervised methods for learning invariant features will be described that are based on sparse coding and sparse auto-encoders: convolutional sparse auto-encoders, invariance through group sparsity, invariance through lateral inhibition, and invariance through temporal constancy. The methods are used to pre-train convolutional networks (ConvNets). ConvNets are biologically-inspired architectures consisting of multiple stages of filter banks, interspersed with non-linear operations, spatial pooling, and contrast normalization operations.

Several applications will be shown, including a a pedestrian detector, a category-level object recognition system that can be trained on the fly, and a 'scene parsing' system that can label every pixel in an image with the category of the object it belongs to. Specialized FPGA and ASIC-based hardware architecture that run these systems in real time will also be described.

Sparsity Control for Robustness and Social Data Analysis

Dr. Georgios B. Giannakis, ADC Chair in Wireless Telecommunications in Electrical and Computer Engineering
University of Minnesota

Dr. Georgios B. Giannakis spoke on Friday, October 5th, 2012 at 12:50PM in Engineering Building II, Room 1230

The information explosion propelled by the advent of personal computers, the Internet, and the global-scale communications has rendered statistical learning from data increasingly important for analysis and processing. The ability to mine valuable information from unprecedented volumes of data will facilitate preventing or limiting the spread of epidemics and diseases, identifying trends in global financial markets, protecting critical infrastructure including the smart grid, and understanding the social and behavioral dynamics of emergent social-computational systems. Along with data that adhere to postulated models, present in large volumes of data are also those that do not -- the so-termed outliers.

In this talk I will touch upon several issues that pertain to resilience against outliers, a fundamental aspect of statistical inference tasks such as estimation, model selection, prediction, classification, tracking, and dimensionality reduction, to name a few. The recent upsurge of research toward compressive sampling and parsimonious signal representations hinges on signals being sparse, either naturally, or, after projecting them on a proper basis. I will start by introducing a neat link between the seemingly unrelated notions of sparsity and robustness against outliers, even when the signals involved are not sparse. It will be argued that controlling sparsity of model residuals leads to statistical learning algorithms that are computationally affordable and universally robust to outlier models. I will highlight a few relevant application domains that include preference measurement for consumer utility function estimation in marketing, and load curve cleansing -- a critical task in power systems engineering and management.

In the second part of the talk, I will switch focus towards robust principal component analysis (PCA) algorithms, which are capable of extracting the most informative low-dimensional structure from (grossly corrupted) high-dimensional data. Beyond its ties to robust statistics, the developed outlier-aware PCA framework is versatile to accommodate scalable algorithms to: i) track the low-rank signal subspace as new data are acquired in real time; and ii) determine principal components robustly in (possibly) infinite-dimensional feature spaces. Synthetic and real data tests corroborate the effectiveness of the proposed robust PCA schemes, when used to identify aberrant responses in personality assessment surveys, as well as unveil communities in social networks, and intruders from video surveillance data.

Control over Lossy Networks: The Interplay of Coding and Control

D.B. Hassibi, Professor and Executive Officer of Electrical Engineering
California Institute of Technology, Pasadena, CA

D.B. Hassibi spoke on Friday, October 12th, 2012 at 12:50PM in Engineering Building II, Room 1230

Two theories that have served as the underpinning of many of the technological advancements of the past six decades are information theory and control theory. The former spawned much of today's telecommunications and information technologies and deals with how to reliably transmit information over unreliable channels. It does so by ignoring real-time constraints and allowing for arbitrary long delays in encoding and decoding at the transmitter and receiver. The latter is responsible for advancements in the space age, guidance, etc., and developed independently, ostensibly because it had to deal with real-time constraints upfront and since controllers must take action using information only currently available. This approach works fine when the plant, controller and observer are collocated. However, there are ever-increasing applications where these entities are distributed in different locations and where they exchange information (measurements and control signals) over unreliable channels and networks. It is not hard to show that, in such settings, a purely information-theoretic or purely control-theoretic approach does not work: one needs to deal with both the real-time constraints and the underlying unreliability in a simultaneous and systematic way.

We will review the works of Schulman and Sahai, developed over the past two decades, that study such problems and that introduce the notions of "tree codes" and "anytime capacity", respectively. Tree codes are a new construct in coding theory that allows real-time control over unreliable channels. While their existence was shown by Schulman in 1994, the field has largely remained dormant because to date there have been no explicit constructions of tree codes and no efficient encoding and decoding schemes. We will show the existence with "high probability" of "linear" tree codes and, for the first time, construct explicit codes with efficient encoding and decoding for the erasure channel. We show the efficacy of the method by stabilizing example unstable plants over erasure channels, and argue how this enables the solution of several problems which were hitherto beyond reach.

Sparse Subspace Classification and Clustering

Dr. Rene E. Vidal, Associate Professor of Biomedical Engineering, Computer Science, Mechanical Engineering, and Electrical and Computer Engineering
Center for Imaging Science, Johns Hopkins University

Dr. Rene E. Vidal spoke on Friday, October 26th, 2012 at 12:50PM in Engineering Building II, Room 1230

In many problems in signal/image processing, machine learning and computer vision, data in multiple classes lie in multiple low-dimensional subspaces of a high-dimensional ambient space. We consider the two problems of classification and clustering of data in a union subspaces using sparse representation techniques. We use the idea that the collection of data forms a self-expressive dictionary in which a new data point can write itself as a linear combination of points from the same class/subspace. First, we consider the classification problem where the training data in each class form a few groups of the dictionary and correspond to a few subspaces. We formulate the classification problem as finding a few active subspaces in the union of subspaces using two classes of convex optimization programs. We investigate conditions under which the proposed optimization programs recover the desired solution. Next, we consider the clustering problem, where the goal is to cluster the data in a union of subspaces so that data points in each cluster correspond to points in the same subspace. We propose a convex optimization program based on sparse representation and use its solution to infer the clustering of data using spectral clustering. We investigate conditions under which the proposed convex program successfully finds a sparse representation of each point as a linear combination of points from the same subspace. We demonstrate the efficacy of the proposed classification and clustering algorithms on face classification, face clustering and motion segmentation.

Wavelets on Graphs: Theory and Applications

Dr. Antonio Ortega, Professor and Associate Chair of EE-Systems
Signal and Image Processing Institute Department of Electrical Engineering University of Southern California

Dr. Antonio Ortega spoke on Friday, November 16th, 2012 at 12:50PM in Engineering Building II, Room 1230

USAWavelet transforms have become popular tools for numerous signal processing tasks, from compression to analysis or denoising. These transforms provide a class of signal representations with flexible time (or space) and frequency localization. Recent extensions of these transforms have been targeted to incorporate arbitrary directionality in the transform (e.g., Bandelets, Contourlets).

In this presentation we focus on wavelet-like, multiresolution transforms for datasets that are defined on arbitrary graphs. This is an area that has started to attract some interest only very recently and yet has the potential to have significant impact in a number of applications. Examples of datasets that could be seen as graphs include data distributed in a sensor network, image data traversed in arbitrary fashion, or data available in online social networks.

We first provide an overview of our recent work in the development of wavelets for graphs data. In particular we show constructions based on lifting as well as an example design based simple graph filters. These are among the first critically sampled wavelet representations that have been proposed for arbitrary graph data.

Along the way we provide an overview of two potential applications of these transforms in i) distributed data gathering in a sensor network and ii) image/video compression.

Let the Data Speak for Itself: Data-Driven Learning of Sparse Signal Models

Yoram Bresler, Professor of Electrical and Computer Engineering and Bioengineering
University of Illinois at Urbana-Champaign

Yoram Bresler spoke on Friday, November 30th, 2012 at 12:50PM in Engineering Building II, Room 1230

The sparsity of signals and images in a certain transform domain or dictionary has been exploited in many applications in signal and image processing, including compression, denoising, and notably in compressed sensing, which enables accurate reconstruction from undersampled data. These various applications used sparsifying transforms such as DCT, wavelets, curvelets, and finite differences, all of which had a fixed, analytical form. Recently, sparse representations that are directly adapted to the data have become popular, especially in applications such as image denoising, and inpainting.

We describe two contributions to this new framework. First, we describe a novel approach for simultaneously learning the dictionary and reconstructing the image from highly undersampled data. Numerical experiments on magnetic resonance images of several anatomies demonstrate dramatic improvements on the order of 4-18 dB in reconstruction error and doubling of the acceptable undersampling factor compared to previous compressed sensing methods. Second, we describe a new formulation for data-driven learning of sparsifying transforms. While there has been extensive research on learning synthesis dictionaries and some recent work on learning analysis dictionaries, the idea of learning sparsifying transforms has received no attention. We show the superiority of our learned transforms over analytical sparsifying transforms such as the DCT for signal and image representation. We also show promising performance in image denoising using the learnt transforms, which compares favorably with approaches involving learnt synthesis dictionaries, but at orders of magnitude lower computational cost.

Sheaves For Engineering Problems

Dr. Michael Robinson, Assistant Professor
American University

Dr. Michael Robinson spoke on Friday, January 18th, 2013 at 12:50PM in Engineering Building II, Room 1230

Many systems operate by taking local measurements and exerting local control. The mathematical abstraction that describes locality and local data is that of a "sheaf." Sadly, sheaves have typically been avoided in practice (even among mathematicians), due to the highly technical nature of the theory. However, the little-known thesis of Shepard (Brown University) showed how to avoid much of the technicality while retaining a compelling and useful theory. I will outline the key aspects of this theory, and discuss applications to several engineering problems of current interest.

Geometry of Spectral Analysis for Statistical Estimation, Image Analysis, Track

Dr. Tryphone T. Georgiou, Professor of Electrical and Computer Engineering
University of Minnesota

Dr. Tryphone T. Georgiou spoke on Friday, February 1st, 2013 at 1:00PM in Engineering Building II, Room 1230

Sparse Matrix Models for Finding Good Representatives and Constraining Network

Dr. Guillermo Sapiro, Edmund T. Pratt, Jr. Professor of Electrical and Computer Engineering
Duke University

Dr. Guillermo Sapiro spoke on Friday, February 15th, 2013 at 1:00PM in Engineering Building II, Room 1230

Games, Privacy and Distributed Inference For the Smart Grid

Dr. H. Vincent Poor, Michael Henry Strater University Professor
Princeton University

Dr. H. Vincent Poor spoke on Friday, March 1st, 2013 at 1:00PM in Engineering Building II, Room 1230

Smart grid involves the imposition of an advanced cyber layer atop the physical layer of the electricity grid in order to improve the efficiency and lower the cost of power use and distribution, and to allow for the effective integration of variable energy sources and storage modes into the grid. This cyber-physical setting motivates the application of many techniques from the information and systems sciences to problems arising in the electricity grid, and considerable research effort has been devoted to such application in recent years. This talk will describe recent work on three aspects of this problem: applications of game theory to smart grid design; characterization of the fundamental tradeoff between privacy and utility of information sources arising in the grid; and distributed inferential algorithms that are suitable for the topological constraints imposed by the structure of the grid.

Green Wireless Communications: A Time-Reversal Paradigm

Dr. K. J. Ray Liu, Christine Kim Eminent Professor of Information Technology
University of Maryland

Dr. K. J. Ray Liu spoke on Friday, March 15th, 2013 at 1:00PM in Engineering Building II, Room 1230

In recent years, with the explosive growth of wireless communication, the energy consumption of wireless networks and devices is experiencing a dramatic increase. Because of ubiquity of wireless applications, such increasing energy consumption not only results in a high operational cost and an urgent demand for battery/energy capacity to wireless communications operators, but also causes a more severe electromagnetic pollution to the global environment. Therefore, an emerging concept of â��Green Communicationsâ�� has received considerable attention in hope of finding novel solutions to improve energy efficiency, relieve/reduce radio pollution to unintended users, and maintain/improve performance metrics. To qualify as a green wireless technology, one must meet two basic requirements: one is low energy consumption (environmental concerns) and the other is low radio pollution to others (health concerns) besides the intended transmitter and receiver. In this talk, we argue and show that the time-reversal (TR) signal transmission is an ideal paradigm for green wireless communications because of its inherent nature to fully harvest energy from the surrounding environment by exploiting the multi-path propagation to re-collect all the signal energy that would have otherwise been lost in most existing communication paradigms. Our theoretical analysis and simulations show that a potential of over an order of magnitude of power reduction and interference alleviation can be achieved. We also demonstrate a very high multi-path diversity gain exhibiting in a TR system. In essence, TR transmission treats each multi-path as a virtual antenna and makes full use of all the multi-paths. Experimental results obtained from measurements in real RF multi-path environment are shown to demonstrate the great potential of TR-based transmission as an energy-efficient green wireless communication paradigm.

The Computational Magic of the Ventral Stream: Sketch of a Theory (and Why Some Deep Architectures Work)

Dr. Tomaso Poggio, Eugene McDermo Professor in the Dept. of Brain & Cognitive Sciences
MIT

Dr. Tomaso Poggio spoke on Friday, April 12th, 2013 at 1:00PM in Engineering Building II, Room 1230

The talk explores the theoretical consequences of a simple assumption: the computational goal of the feedforward path in the ventral stream â�� from V1, V2, V4 and to IT â�� is to discount image transformations, after learning them during development. The initial assumption is that a basic neural operation consists of dot products between input vectors and synaptic weights â�� which can be modified by learning. It proves that a multi-layer hierarchical architecture of dot-product modules can learn in an unsupervised way geometric transformations of images and then achieve the dual goals of invariance to global affine transformations and of robustness to deformations. These architectures learn in an unsupervised way to be automatically invariant to transformations of a new object, achieving the goal of recognition with one or very few labeled examples. The theory should apply to a varying degree to a range of hierarchical architectures such as HMAX, convolutional networks and related feedforward models of the visual system and formally characterize some of their properties.

Wrinkles on Everest: Persistence and Stability in an Omniscalar World

Dr. Dmitriy Morozov, Postdoctoral Scholar in the Computational Research Division
Lawrence Berkeley National Laboratory

Dr. Dmitriy Morozov spoke on Friday, April 19th, 2013 at 1:00PM in Engineering Building II, Room 1230

In the last decade, persistent homology emerged as a particularly active topic within the young field of computational topology. Homology is a topological invariant that counts the number of cycles in the space: components, loops, voids, and their higher-dimensional analogs. Persistence keeps track of the evolution of such cycles and quantifies their longevity. By encoding physical phenomena as real-valued functions, one can use persistence to identify their significant features.

This talk is an introduction to the subject, discussing the settings in which persistence is effective as well as the methods it employs. As examples, we consider problems of scalar field simplification and non-linear dimensionality reduction. The talk will sketch the budding field of topological data analysis and its future directions.

A Tensor Spectral Approach to Learning Mixed Membership Community Models

Dr. Anima Anandkumar, Assistant Professor of Electrical Engineering and Computer Sciences
University of California - Irvine

Dr. Anima Anandkumar spoke on Friday, April 26th, 2013 at 1:00PM in Engineering Building II, Room 1230

Modeling community formation and detecting hidden communities in networks is a well-studied problem. However, theoretical analysis of community detection has been mostly limited to models with non-overlapping communities such as the stochastic block model. In this paper, we remove this restriction, and consider a family of probabilistic network models with overlapping communities, termed as the mixed membership Dirichlet model, first introduced in Aioroldi et. al. 2008. This model allows for nodes to have fractional memberships in multiple communities and assumes that the community memberships are drawn from a Dirichlet distribution. We propose a unified approach to learning these models via a tensor spectral decomposition method. Our estimator is based on low-order moment tensor of the observed network, consisting of 3-star counts. Our learning method is fast and is based on simple linear algebra operations, e.g. singular value decomposition and tensor power iterations. We provide guaranteed recovery of community memberships and model parameters and present a careful finite sample analysis of our learning method. Additionally, our results match the best known scaling requirements in the special case of the stochastic block model. This is joint work with Rong Ge, Daniel Hsu and Sham Kakade.

Featuring SAS Professionals

Dr. James Cox & Dr. Zheng Zhao, SR. Dev Manager, SAS Text Miner
SAS Institute Inc.

Dr. James Cox & Dr. Zheng Zhao spoke on Friday, September 6th, 2013 at 1:00PM in Engineering Building II, Room 1230

General Approaches for working with large, sparse feature sets

Dr. James Cox

Many different application areas utilize large, sparse feature sets, including text, genomic SNPs, image processing, recommendation engines, sensor data, web logs, and item purchase data. Since most machine learning utilizes an observation by variable format, researchers utilizing such feature sets often end up inventing their own techniques; but limiting it to their application area. I propose that we develop a general toolkit for working with such data, and will present some general ideas of what this might look like.

Massively Parallel Feature Selection: An Approach Based on Variance Preservation

Dr. Zheng Zhao

We present a novel large-scale feature selection algorithm that is based on variance analysis. The algorithm selects features by evaluating their abilities to explain data variance. The algorithm was implemented as a SAS High-Performance Analytics procedure, which can read data in distributed form and perform parallel feature selection in both symmetric multiprocessing mode (SMP) and massively parallel processing mode (MPP).

Bios:

James A. Cox has been the development manager for SAS Text Miner ever since its inception twelve years ago. Jim holds a Ph.D. in Cognitive Psychology and Computer Science from UNC-Chapel Hill.

Zheng Zhao received the BEng and Meng degrees in computer science and engineering from Harbin Institute of Technology (HIT) and the PhD degree in computer science and engineering from Arizona State University (ASU).

The Power of Random Projections

Dr. Alex Smola, Professor
Carnegie Mellon University

Dr. Alex Smola spoke on Friday, September 20th, 2013 at 1:00PM in Engineering Building II, Room 1230

Randomness is an effective tool to better algorithms for document analysis. Depending on its use it can lead to methods that are either more memory efficient, faster to compute, or work in a lower dimensional space. In this talk I will give an overview over techniques such as locality sensitive hashing, shingles and the min hash, and show their relation to recent developments such as conditionally random sampling, the hash kernel, or fast exponential families sampling

Learning Classification Rules via Boolean Compressed Sensing with Application to Workforce Analytics

Dr. Kush R. Varshney, Research Staff Member
IBM - Business Analytics and Mathematical Sciences Dept.

Dr. Kush R. Varshney spoke on Friday, October 4th, 2013 at 1:00PM in Engineering Building II, Room 1230

Motivated by business analytics applications such as identifying employees at risk of voluntary attrition, we propose an interpretable rule-based classification system based on ideas from Boolean compressed sensing. We represent the problem of learning individual conjunctive clauses or individual disjunctive clauses as a Boolean group testing problem, and apply a novel linear programming relaxation to find solutions. We derive results for exact rule recovery which parallel the conditions for exact recovery of sparse signals in the compressed sensing literature. This is an exciting development in rule learning where most prior work focused on heuristic solutions. Furthermore we construct rule sets from these learned clauses using set covering and boosting. We show competitive classification accuracy using the proposed approach.

Robust compressed sensing: How undersampling introduces noise and what we can do about it

Dr. Galen Reeves, Assistant Professor, Department of Electrical & Computer Engineering and the Department of Statistical Science
Duke University

Dr. Galen Reeves spoke on Friday, October 18th, 2013 at 1:00PM in Engineering Building II, Room 1230

Successful high-resolution signal reconstruction -- in problems ranging from astronomy to biology to medical imaging -- depends crucially upon our ability to make the most out of indirect, incomplete, and inaccurate data. A large and active area of research, known as compressed sensing, has drawn researchers from applied mathematics, information theory, mathematical statistics, and optimization theory to focus on the design and analysis of computational reconstruction methods. These methods take advantage of low dimensional structure inherent in the data (e.g. sparsity, low rank) to overcome that fact that the number of unknowns may far exceed the number of knowns.

In this talk, I will explain a key theoretical insight about signal recovery from undersampled data: In many cases, the effect on the end user is the same as if each component of the unknown signal had been observed directly after being corrupted by independent random noise. Using this insight as a guiding principle, I will then show how we can give precise answers to a variety of key engineering questions concerning the relaxation of model assumptions, the minimax sensitivity to noise, and the design of near-optimal adaptive strategies which learn the statistics of the underlying data.

ICA and IVA: Theory, Connections, and Applications to Medical Imaging

Tülay Adali, Professor of Computer Science and Electrical Engineering
The University of Maryland, Baltimore County

Tülay Adali spoke on Friday, November 1st, 2013 at 1:00PM in Engineering Building II, Room 1230

Data-driven methods are based on a simple generative model and hence can minimize the assumptions on the nature of data. They have emerged as promising alternatives to the traditional model-based approaches in many applications where the underlying dynamics are hard to characterize. Independent component analysis (ICA), in particular, has been a popular data-driven approach and an active area of research. Starting from a simple linear mixing model and imposing the constraint of statistical independence on the underlying components, ICA can recover the linearly mixed components subject to only a scaling and permutation ambiguity. It has been successfully applied to numerous data analysis problems in areas as diverse as biomedicine, communications, finance, geophysics, and remote sensing.

This talk reviews the fundamentals and properties of ICA, and provides a unified view of two main approaches for achieving ICA, those that make use of non-Gaussianity and sample dependence. Then, the generalization of ICA for analysis of multiple datasets, independent vector analysis (IVA), is introduced and the connections between ICA and IVA are highlighted, especially in the way both approaches make use of signal diversity. Examples are presented to demonstrate the application of ICA and IVA to analysis of functional magnetic resonance imaging data as well as fusion of data from multiple imaging modalities.

Neural Decoding and Restoration of Motor Skills in Patients with Disorders of the Nervous System

Dr. V. John Matthews, Professor of Electrical and Computer Engineering
University of Utah

Dr. V. John Matthews spoke on Friday, November 15th, 2013 at 1:00PM in Engineering Building II, Room 1230

Recent technological innovations such as functional neural stimulation (FNS) offer considerable benefits to paralyzed individuals. FNS can produce movement in paralyzed muscles by the application of electrical stimuli to the nerves innervating the muscles. The first part of this talk will describe how smooth muscle movements can be evoked using Utah slanted electrode arrays (USEAs) inserted into the motor nerves of the peripheral nervous system. The standard 4 x 4 mm USEAs contain 100 electrodes of varying lengths. Implantation of a USEA in a peripheral nerve allows highly selective electrical access to individual and small groups of axons. We will review approaches for designing asynchronously interleaved stimulation signals applied via individual electrodes in the arrays to evoke smooth, fatigue-resistant force that closely resembles normal motor function. The second part of this talk will describe efforts to decode cortical surface potentials, recorded with dense grids of microelectrodes. Decoding human intent from neural signals is a critical component of brain-computer interfaces. This information can then be used to control the muscles in tasks involving restoration of motor skills or to control a robot that performs desired tasks. We will discuss recent work on decoding neural data collected from patients implanted with microelectrode arrays. The talk will conclude with a discussion of some of the current research challenges in this area.

Nonlinear Waves from Beaches to Photonics

Dr. Mark Ablowitz, Professor and the department chair of Applied Mathematics
University of Colorado

Dr. Mark Ablowitz spoke on Friday, January 17th, 2014 at 1:00PM in Engineering Building II, Room 1230

The study of localized waves has a long history dating back to the discoveries in the 1800s describing solitary water waves in shallow water. In the 1960s researchers found that certain equations, such as the Korteweg-deVries (KdV) and nonlinear Schrodinger (NLS) equations arise widely. Both equations admit localized solitary wave--or soliton solutions. Employing a nonlocal formulation of water waves interesting asymptotic reductions of water waves are obtained. Some solutions will be discussed as well as how they relate to ocean observations. In the study of photonic lattices with simple periodic potentials, discrete and continuous NLS equations arise. In non-simple periodic, hexagonal or honeycomb lattices, novel discrete Dirac-like systems and their continuous analogs can be derived. They are found to have interesting properties. Since honeycomb lattices occur in the material graphene, the optical case is termed photonic graphene.

Numerical Linear Algebra Methods in Data Mining

Dr. Yousef Saad, College of Science and Technology Distinguished Professor, Computer Science and Engineering
University of Minnesota

Dr. Yousef Saad spoke on Friday, January 31st, 2014 at 1:00PM in Engineering Building II, Room 1230

The field of data mining is the source of many new, interesting, and sometimes challenging, linear algebra problems. In fact, one can say that data mining and machine learning are now beginning to shape a "new chapter" in numerical linear algebra, replacing Computational Fluid Dynamics and PDEs as the main source of 'model' problems in Numerical Linear Algebra. The talk will start with an overview of the key concepts and then discuss dimension reduction methods which play a major role. We will illustrate these concepts with a few applications, including information retrieval; face recognition and matrix completion for recommender systems. An important emerging application is 'materials informatics'. The synergy between high-performance computing, efficient electronic structure algorithms, and data mining, may potentially lead to major discoveries in materials. We will report on our first experiments in 'materials informatics', a methodology which blends data mining and materials scienc

An MCMC Approach to Lossy Compression of Analog Sources

Dr. Dror Baron, Assistant Professor, Department of Electrical and Computer Engineering
NC State University

Dr. Dror Baron spoke on Friday, September 3rd, 2010 at 1:00PM in Engineering Building II, Room 2213

Motivated by the Markov chain Monte Carlo (MCMC) relaxation method of Jalali and Weissman, we propose a lossy data compression algorithm for continuous amplitude analog sources that relies on a finite reproduction alphabet that grows with the input length. Our algorithm asymptotically achieves the optimum rate distortion (RD) function universally for stationary ergodic continuous amplitude sources. However, the large alphabet slows down the convergence to the RD function, and is thus an impediment in practice. We thus propose an MCMC-based algorithm that uses a (smaller) adaptive reproduction alphabet. In addition to computational advantages, the reduced alphabet accelerates convergence to the RD function, and is thus more suitable in practice.

Anticipated extensions of this algorithm could be added to existing image and video compression standards. Taking into account that by some accounts video downloads account for over 70% of global internet data usage, fundamental improvements in lossy compression could make a significant impact. The speaker will outline ideas for future research along these lines toward the end of the talk.

Dror Baron received the B.Sc. and M.Sc. degrees from the Technion-Israel Institute of Technology, Haifa, Israel, in 1997 and 1999, and the Ph.D. degree from the University of Illinois at Urbana-Champaign in 2003, all in electrical engineering. After several years performing research in academic and industry settings, he joined the Department of Electrical and Computer Engineering at North Carolina State University in 2010 as an assistant professor, and is currently pursuing research in information theory and signal processing.

Peak Detection and Topological Inference in Images

Dr. Armin Schwartzman
North Carolina State University

Date: March 21, 2014 **Time: 12:50 p.m.** **Place: EBII 1230**

Abstract:

A common problem in image analysis is to find local significant regions, either for a single image or for the difference between two or more images. In this talk, I will describe how to approach the image inference problem from a multiple testing point of view, and how random field theory comes to the rescue in the estimation of global error rates, such as the family-wise error rate. In particular, I will emphasize the role that topology plays in the solution via the Euler characteristic of the excursion set of a random field. Moreover, I will suggest how the Euler characteristic may enable estimation of topological error rates, turning the signal detection problem into a topological inference one.

Bio:

Armin Schwartzman was born and grew up in Lima, Peru. He received his undergraduate degree in Electrical Engineering from the Technion - Israel Institute of Technology, in Haifa, Israel and a Master's degree in Electrical Engineering from Caltech. After four years in hi-tech, doing modem system design at Rockwell Semiconductor in San Diego, CA, and analysis of cardiac electrograms at Biosense Webster in Haifa, Israel, he went on to get his Ph.D. in Statistics from Stanford University, where he worked on statistics for random positive definite matrices and false discovery rate inference in multiple testing, two statistical problems arising in the analysis of Diffusion Tensor Imaging (DTI) data. Prior to coming to NCSU, he spent 6 years as Assistant Professor of Biostatistics at Harvard and one year as a visiting professor in Electrical Engineering at the Technion. Dr. Schwartzman's current research is mainly in the area of statistical image analysis, with applications to brain imaging and the environment.

On the Influence of the Seed Graph in the Preferential Attachment Model

Dr. Sebastien Bubeck
Princeton University

Date: February 28, 2014 **Time: 12:50 p.m.** **Place: EBII 1230**

Abstract:

We are interested in the following question: suppose we generate a large graph according to the linear preferential attachment model---can we say anything about the initial (seed) graph? A precise answer to this question could lead to new insights for the diverse applications of the preferential attachment model. In this work we focus on the case of trees grown according to the preferential attachment model. We first show that the seed has no effect from a weak local limit point of view. On the other hand, we conjecture that different seeds lead to different distributions of limiting trees from a total variation point of view. We take some steps in proving this conjecture by focusing on star seeds.

Bio:

Sebastien Bubeck is an assistant professor in the department of Operations Research and Financial Engineering at Princeton University. He joined Princeton after a postdoc at the Centre de Recerca Matematica in Barcelona, where he was working with Gabor Lugosi. He received his Ph.D. in mathematics from the University of Lille 1, advised by Remi Munos, after undergraduate studies at the Ecole Normale Superieure de Cachan. His research focuses on the mathematics of machine learning, with emphasis on problems related to multi-armed bandits. His work was recognized by several awards, such as the COLT 2009 best student paper award, and the Jacques Neveu prize 2010 for the best French Ph.D. in Probability/Statistics.

Distributed sensing and decision-making in animal groups

Dr. Iain D. Couzin
Princeton University

Date: April 11, 2014 **Time: 12:50 p.m.** **Place: EBII 1230**

Abstract:
Effective information transfer among individual components is essential for the coordination of collective behavior in both natural and technological domains. Revealing the time-varying structure of the networks underlying information flow in such complex systems is a central challenge. For example, a long-standing goal of neuroscience has been to establish both the physical and functional connectivity of decision-making circuits. Dynamic networks of interaction also underlie the collective behavior of groups of organisms, such as schooling fish or flocking birds, and yet the comparable issue of establishing the structure and nature of the interaction network by which grouping organisms make collective decisions has remained almost entirely neglected. One of the challenges is that such communication networks have no physical form. I will describe technology that we have developed that allows us to reveal the hidden structure of such networks in real animal groups: Automated tracking and body posture mapping, combined with computational visual field reconstruction, allows us to determine the functional mapping between high-dimensional visual input and relatively low-dimensional motor output. This allows reconstruction of the time-varying, directed and weighted networks of social influence, and susceptibility to influence. The topology of these networks is shown to differ greatly from those previously assumed in theoretical and experimental studies of animal grouping. Quantifying the network properties of interaction networks allows us to predict how, and the degree to which, behavioral change (social contagion) propagates through groups, before it actually occurs. It is also shown that emergent problem solving is the predominant mechanism by which such groups sense, and respond to, complex environments. This distributed sensing is shown to be highly robust and readily applicable to robotic applications. Finally I will explore consensus decision-making in animal collectives, using both experiments and theory, revealing the crucial role that uninformed individuals play, notably in promoting democratic consensus (despite the inability for individuals to explicitly 'vote'), and in enhancing the speed and accuracy of collective decision-making. These results, in combination, demonstrate how distributed cognition emerges from the dynamics of the network of social interactions in animal groups, and provides new understanding of how biological collectives may inform robotics and computational optimization.

Bio:
Dr. Iain Couzin is a Professor in the Department of Ecology and Evolutionary Biology at Princeton University, where he manages the Couzin Lab. Previously he was Royal Society University Research Fellow in the Department of Zoology, University of Oxford, and Junior Research Fellow in the Sciences at Balliol College, Oxford. His work aims to reveal the fundamental principles that underlie evolved collective behavior, and consequently his research includes the study of a wide range of biological systems, from brain tumors to insect swarms, fish schools and human crowds. In recognition of his research he was recipient of a Searle Scholar Award in 2008, the Mohammed Dahleh Award in 2009, Popular Science Magazines "Brilliant 10″ award in 2010, PopTech Science and Public Leadership award in 2011 and National Geographic Emerging Explorer Award in 2012.

NC STATE UNIVERSITY

Electrical & Computer Engineering

Interdisciplinary Distinguished Seminar Series

The Poisson Communication Channel

Dr. Prakash Narayan
University of Maryland

Date: April 25, 2014 **Time: 12:50 p.m.** **Place: EBII 1230**

Abstract:

The Poisson channel model is an apt representation of a direct-detection dark-current-limited optical communication link. The input to the channel controls the instantaneous rate of a Poisson point process at the photodetector output. Additionally, in a free-space optical communication link, atmospheric turbulence causes random variations in the refractive index of air at optical wavelengths, resulting in optical ``fading'' that can be combatted by adaptive power control and MIMO techniques as in RF communication. This talk will survey the information theory of the Poisson channel, and implications for optical communication.

Bio:

Dr. Prakash Narayan received the B.Tech. degree in Electrical Engineering from the Indian Institute of Technology, Madras, and the M.S. and D.Sc. degrees in Systems Science and Mathematics, and Electrical Engineering, respectively, from Washington University, St. Louis, MO. He is Professor of Electrical and Computer Engineering at the University of Maryland, College Park, with a joint appointment at the Institute for Systems Research. He has held visiting appointments at ETH, Zurich, the Technion, Haifa, the Renyi Institute of the Hungarian Academy of Sciences, Budapest, Universitat Bielefeld, LADSEB, Padova, and the Indian Institute of Science, Bangalore. Narayan's research and teaching interests are in multiuser information and communication theory, cryptography, broadband communication networks, and information theory and statistics. He has served as Associate Editor for Shannon Theory for the IEEE Transactions on Information Theory and is currently on its Executive Editorial Board. He was a member of the Board of Governors of the IEEE Information Theory Society, and is a Fellow of the IEEE.

Covert Network Detection

Dr. Steven Smith
Massachusetts Institute of Technology

Date: June 9, 2014 **Time: 12:50 p.m.** **Place: MRC 136**

Abstract:

Network detection is an important capability in many areas of applied research in which data can be represented as a graph of entities and relationships. Oftentimes the object of interest is a relatively small subgraph in an enormous, potentially uninteresting background. This characteristic of the problem can cause it to be labeled as a "big data" problem. Graph partitioning and network discovery have been major research areas over the last ten years, driven by interest in internet search, cyber security, social networks, and criminal or terrorist activities. The specific problem of covert network discovery is addressed as a special case of graph partitioning in which membership in a small subgraph of interest must be determined and an emphasis is placed on the hard problem of detecting covert networks, which across application domains are strictly compartmented and adopt secure conops to avoid detection and adapt to losses. An exploitation architecture designed to use Multi-INT for network discovery is presented with a motivating example. Algebraic graph theory is used as the basis to analyze and compare different network detection methods. A new Bayesian network detection framework is introduced that partitions the graph based on prior information and direct observations. The new approach, called space-time threat propagation, is proved to maximize the probability of detection and is therefore optimum in the Neyman-Pearson sense. This optimality criterion is compared to spectral community detection approaches that divide the global graph into subsets or communities with optimal connectivity properties. We also explore a new generative stochastic model for covert networks and analyze using receiver operating characteristics the detection performance of both classes of optimal detection techniques. Detection performance results consistent with theory are provided using both stochastic blockmodel simulations of covert networks embedded in a large background, and threat networks from real-world MOVINT and Email networks.

Bio:

Steven Thomas Smith received the B.A.Sc. degree in electrical engineering and mathematics from the University of British Columbia, Vancouver, BC in 1986 and the Ph.D. degree in applied mathematics from Harvard University, Cambridge, MA in 1993. From 1986 to 1988 he was a research engineer at ERIM, Ann Arbor, MI, where he developed morphological image processing algorithms. He is currently a senior member of the technical staff at MIT Lincoln Laboratory, which he joined in 1993. His research involves algorithms for adaptive signal processing, detection, and tracking to enhance radar and sonar systems performance. He has taught signal processing courses at Harvard and for the IEEE. His most recent work addresses intrinsic estimation and superresolution bounds, mean and variance CFAR, advanced tracking methods, and space-time adaptive processing algorithms. He was an associate editor of the IEEE Transactions on Signal Processing (2000-2002), and received the SIAM outstanding paper award in 2001.

Interdisciplinary Distinguished Seminar Series

Fundamental problems in science and engineering have become increasingly interdisciplinary, requiring knowledge and expert input from several areas of research. This is both challenging and exciting. The primary challenge faced by researchers is to keep abreast of new developments in tangential research areas to their own, not to mention those which are considered different. The increasing complexity of newly arising problems has on the other hand, invariably required a multifaceted approach to viewing and understanding them, and ultimately produce a solution.

To that end, the Department of Electrical and Computer Engineering hosts a regularly scheduled seminar series with preeminent and leading reseachers in the US and the world, to help promote North Carolina as a center of innovation and knowledge and to ensure safeguarding its place of leading research.

The Interdisciplinary Distinguished Speaker Series is funded through a grant provided by the US Army Research Office.

All talks are scheduled to take place at 1 pm in Room 1230 at Engineering Building II (unless noted otherwise), on NC State's award-winning Centennial Campus. Each talk will be free and open to the public.

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Past Lecturers

JAN **31** 2014

Numerical Linear Algebra Methods in Data Mining

Dr. Yousef Saad, College of Science and Technology Distinguished Professor, Computer Science and Engineering
University of Minnesota

Dr. Yousef Saad spoke on Friday, January 31st, 2014 at 1:00PM in Engineering Building II, Room 1230

Watch the Presentation

JAN **17** 2014

Nonlinear Waves from Beaches to Photonics

Dr. Mark Ablowitz, Professor and the department chair of Applied Mathematics
University of Colorado

Dr. Mark Ablowitz spoke on Friday, January 17th, 2014 at 1:00PM in Engineering Building II, Room 1230

Watch the Presentation

NOV **15** 2013

Neural Decoding and Restoration of Motor Skills in Patients with Disorders of the Nervous System

Dr. V. John Matthews, Professor of Electrical and Computer Engineering
University of Utah

Dr. V. John Matthews spoke on Friday, November 15th, 2013 at 1:00PM in Engineering Building II, Room 1230

Watch the Presentation

NOV **01**

ICA and IVA: Theory, Connections, and Applications to Medical Imaging

Tülay Adali, Professor of Computer Science and Electrical Engineering
The University of Maryland, Baltimore County

2013

Tülay Adali spoke on Friday, November 1st, 2013 at 1:00PM in Engineering Building II, Room 1230

OCT
18
2013

Robust compressed sensing: How undersampling introduces noise and what we can do about it

Dr. Galen Reeves, Assistant Professor, Department of Electrical & Computer Engineering and the Department of Statistical Science
Duke University

Dr. Galen Reeves spoke on Friday, October 18th, 2013 at 1:00PM in Engineering Building II, Room 1230

Watch the Presentation

OCT
04
2013

Learning Classification Rules via Boolean Compressed Sensing with Application to Workforce Analytics

Dr. Kush R. Varshney, Research Staff Member
IBM - Business Analytics and Mathematical Sciences Dept.

Dr. Kush R. Varshney spoke on Friday, October 4th, 2013 at 1:00PM in Engineering Building II, Room 1230

Watch the Presentation

SEP
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2013

The Power of Random Projections

Dr. Alex Smola, Professor
Carnegie Mellon University

Dr. Alex Smola spoke on Friday, September 20th, 2013 at 1:00PM in Engineering Building II, Room 1230

Watch the Presentation

SEP
06
2013

Featuring SAS Professionals

Dr. James Cox & Dr. Zheng Zhao, SR. Dev Manager, SAS Text Miner
SAS Institute Inc.

Dr. James Cox & Dr. Zheng Zhao spoke on Friday, September 6th, 2013 at 1:00PM in Engineering Building II, Room 1230

Watch the Presentation

APR
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2013

A Tensor Spectral Approach to Learning Mixed Membership Community Models

Dr. Anima Anandkumar, Assistant Professor of Electrical Engineering and Computer Sciences
University of California - Irvine

Dr. Anima Anandkumar spoke on Friday, April 26th, 2013 at 1:00PM in Engineering Building II, Room 1230

Watch the Presentation

APR
19
2013

Wrinkles on Everest: Persistence and Stability in an Omniscalar World

Dr. Dmitriy Morozov, Postdoctoral Scholar in the Computational Research Division
Lawrence Berkeley National Laboratory

Dr. Dmitriy Morozov spoke on Friday, April 19th, 2013 at 1:00PM in Engineering Building II, Room 1230

Watch the Presentation

APR
12
2013

The Computational Magic of the Ventral Stream: Sketch of a Theory (and Why Some Deep Architectures Work)

Dr. Tomaso Poggio, Eugene McDermo Professor in the Dept. of Brain & Cognitive Sciences
MIT

Dr. Tomaso Poggio spoke on Friday, April 12th, 2013 at 1:00PM in Engineering Building II, Room 1230

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MAR
15
2013

Green Wireless Communications: A Time-Reversal Paradigm

Dr. K. J. Ray Liu, Christine Kim Eminent Professor of Information Technology
University of Maryland

Dr. K. J. Ray Liu spoke on Friday, March 15th, 2013 at 1:00PM in Engineering Building II, Room 1230

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MAR
01
2013

Games, Privacy and Distributed Inference For the Smart Grid

Dr. H. Vincent Poor, Michael Henry Strater University Professor
Princeton University

Dr. H. Vincent Poor spoke on Friday, March 1st, 2013 at 1:00PM in Engineering Building II, Room 1230

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FEB
15
2013

Sparse Matrix Models for Finding Good Representatives and Constraining Network

Dr. Guillermo Sapiro, Edmund T. Pratt, Jr. Professor of Electrical and Computer Engineering
Duke University

Dr. Guillermo Sapiro spoke on Friday, February 15th, 2013 at 1:00PM in Engineering Building II, Room 1230

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FEB
01
2013

Geometry of Spectral Analysis for Statistical Estimation, Image Analysis, Track

Dr. Tryphone T. Georgiou, Professor of Electrical and Computer Engineering
University of Minnesota

Dr. Tryphone T. Georgiou spoke on Friday, February 1st, 2013 at 1:00PM in Engineering Building II, Room 1230

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JAN
18
2013

Sheaves For Engineering Problems

Dr. Michael Robinson, Assistant Professor
American University

Dr. Michael Robinson spoke on Friday, January 18th, 2013 at 12:50PM in Engineering Building II, Room 1230

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NOV
30

Let the Data Speak for Itself: Data-Driven Learning of Sparse Signal Models

Yoram Bresler, Professor of Electrical and Computer Engineering and Bioengineering
University of Illinois at Urbana-Champaign

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2012

Yoram Bresler spoke on Friday, November 30th, 2012 at 12:50PM in Engineering Building II, Room 1230

NOV
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2012

Wavelets on Graphs: Theory and Applications

Dr. Antonio Ortega, Professor and Associate Chair of EE-Systems
Signal and Image Processing Institute Department of Electrical Engineering University of Southern California

Dr. Antonio Ortega spoke on Friday, November 16th, 2012 at 12:50PM in Engineering Building II, Room 1230

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OCT
26
2012

Sparse Subspace Classification and Clustering

Dr. Rene E. Vidal, Associate Professor of Biomedical Engineering, Computer Science, Mechanical Engineering, and Electrical and Computer Engineering
Center for Imaging Science, Johns Hopkins University

Dr. Rene E. Vidal spoke on Friday, October 26th, 2012 at 12:50PM in Engineering Building II, Room 1230

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OCT
12
2012

Control over Lossy Networks: The Interplay of Coding and Control

D.B. Hassibi, Professor and Executive Officer of Electrical Engineering
California Institute of Technology, Pasadena, CA

D.B. Hassibi spoke on Friday, October 12th, 2012 at 12:50PM in Engineering Building II, Room 1230

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OCT
05
2012

Sparsity Control for Robustness and Social Data Analysis

Dr. Georgios B. Giannakis, ADC Chair in Wireless Telecommunications in Electrical and Computer Engineering
University of Minnesota

Dr. Georgios B. Giannakis spoke on Friday, October 5th, 2012 at 12:50PM in Engineering Building II, Room 1230

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SEP
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2012

Deep Learning of Invariant Feature Hierarchies

Yann LeCun, Silver Professor of Computer Science and Neural Science
Courant Institute of Mathematical Sciences and Center for Neural Science, New York University

Yann LeCun spoke on Friday, September 21st, 2012 at 12:50PM in Engineering Building II, Room 1230

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SEP
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2012

The Road to Terabit Satellites: Science-Fiction or Science?

Claudio Sacchi, Assistant Professor
University of Trento, Dept. of Information Engineering & Computer Science, Disi, Italy

Claudio Sacchi spoke on Friday, September 14th, 2012 at 12:50PM in Engineering Building II, Room 1230

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SEP

Applied Topology and Matrix Methods

Dr. Anil Hirani, Applied Mathematician

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07
2012

Dept. of Computer Science - University of Illinois at Urbana-Champaign

Dr. Anil Hirani spoke on Friday, September 7th, 2012 at 12:50PM in Engineering Building II, Room 1230

APR
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2012

Design and Performance of Adaptive Systems, Based on Evolutionary Optimization Strategies

Dr. W. K. Jenkins, Professor of Electrical Engineering
The Pennsylvania State University

Dr. W. K. Jenkins spoke on Friday, April 20th, 2012 at 12:50PM in Engineering Building II, Room 1230

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APR
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2012

The Impact of Time Delays in Network Synchronization in a Noisy Environment

Gyorgy Korniss, Professor, Department of Physics and The Social and Cognitive Networks Academic Research Center
Rensselaer Polytechnic Institute

Gyorgy Korniss spoke on Friday, April 13th, 2012 at 12:50PM in Engineering Building II, Room 1230

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APR
06
2012

Controlling Epitaxial Graphene Growth

Dr. D. Kurt Gaskill, Senior Scientist
Advanced SiC Epitaxial Research Laboratory, U.S. Naval Research Laboratory, Washington, DC 20375

Dr. D. Kurt Gaskill spoke on Friday, April 6th, 2012 at 12:50PM in Engineering Building II, Room 1230

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MAR
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2012

Revitalizing the Power Grid Needs, Benefits and Advancements

Dr. Damir Novosel, President
Quanta Technology

Dr. Damir Novosel spoke on Friday, March 23rd, 2012 at 12:50PM in Engineering Building II, Room 1230

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MAR
16
2012

Empirical Mode Decompositions, From basics to recent results

Patrick Flandrin, Research Director
Laboratoire de Physique, Eciole Normale Supérieure de Lyon, France

Patrick Flandrin spoke on Friday, March 16th, 2012 at 12:50PM in Engineering Building II, Room 1230

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FEB
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2012

Super-Turing Computation

Dr. Hava Siegelmann, Associate Professor of Computer Science and Neuroscience
University of Massachusetts Amherst

Dr. Hava Siegelmann spoke on Friday, February 24th, 2012 at 12:50PM in Engineering Building II, Room 1230

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2012

Reformation-Based Approaches to Query Optimization

Dr. Rada Chirkova, Associate Professor, Computer Science Department
North Carolina State University

Dr. Rada Chirkova spoke on Friday, February 17th, 2012 at 12:50PM in Engineering Building II, Room 1230

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FEB
03
2012

Skewed functional processes and their applications

Dr. Ana-Maria Staicu, Assistant Professor, Statistics Department
North Carolina State University

Dr. Ana-Maria Staicu spoke on Friday, February 3rd, 2012 at 12:50PM in Engineering Building II, Room 1230

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JAN
20
2012

A Weight-Based View of Approximate Inference In Graphical Models

Alexander Ihler, Assistant Professor, Department of Computer Science
University of California, Irvine

Alexander Ihler spoke on Friday, January 20th, 2012 at 12:50PM in Engineering Building II, Room 1230

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DEC
09
2011

At the boundaries of high-frequency analog & RF ICs: Speed, energy and uncertainty

David Ricketts, Harvard Innovation Fellow, School of Engineering & Applied Science
Harvard University

David Ricketts spoke on Friday, December 9th, 2011 at 12:50PM in Monteith Research Center (MRC) 136

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DEC
02
2011

Screening For Connections and Hubs In Large Scale Correlation Graphs

Alfred Hero, R. Jamison and Betty Williams Professor of Engineering
University of Michigan

Alfred Hero spoke on Friday, December 2nd, 2011 at 12:50PM in Engineering Building II, Room 1230

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NOV
09
2011

Compressive Sensing-Based MIMO Radar

Athina Petropulu, Chair of the Electrical and Computer Engineering Department
Rutgers University

Athina Petropulu spoke on Wednesday, November 9th, 2011 at 12:50PM in Engineering Building II, Room 1230

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NOV
04
2011

Multiple Uses of Correlation Filters for Biometrics

Vijay Kumar, Professor, Electrical and Computer Engineering Department
Carnegie Mellon University

Vijay Kumar spoke on Friday, November 4th, 2011 at 12:50PM in Engineering Building II, Room 1230

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OCT
21
2011

Greener Video Coding and Processing for the Mobile and Desktop Worlds

Dr. Ricardo L. de Queiroz, Full Professor, Computer Science Department
Universidade Estadual de Campinas, Brazil

Dr. Ricardo L. de Queiroz spoke on Friday, October 21st, 2011 at 12:50PM in Engineering Building II, Room 1230

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OCT
14
2011

Robust Topological Features For Deformation Invariant Image Matching

Dr. Edgar Lobaton, Assistant Professor, Department of Electrical and Computer Engineering
NC State University

Dr. Edgar Lobaton spoke on Friday, October 14th, 2011 at 12:50PM in Engineering Building II, Room 1230

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SEP
23
2011

Bio-Inspired Cognition and Networks

Ali Sayed, Professor of Electrical Engineering
University of California

Ali Sayed spoke on Friday, September 23rd, 2011 at 1:00PM in Engineering Building II, Room 1230

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SEP
02
2011

Fast, Automatic, Photo-realistic, 3D Modeling of Building Interiors

Avideh Zakhor, Professor, EECS
University of California, Berkley

Avideh Zakhor spoke on Friday, September 2nd, 2011 at 12:50PM in Engineering Building II, Room 1230

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AUG
26
2011

Algebraic Statistics

Seth Sullivant, Associate Professor, Mathematics
NC State University

Seth Sullivant spoke on Friday, August 26th, 2011 at 1:00PM in Engineering Building II, Room 1230

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APR
29
2011

Configuration Spaces of Hard Disks

Matthew Kahle, Assistant Professor
Ohio State University

Matthew Kahle spoke on Friday, April 29th, 2011 at 1:00PM in Engineering Building III, Room 2213

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APR
15
2011

Bayesian Alignment of Unlabeled Marked Point Sets Using Random Fields

Dr. Ian Dryden, Professor, Department of Statistics
University of South Carolina

Dr. Ian Dryden spoke on Friday, April 15th, 2011 at 1:00PM in Engineering

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Building III, Room 2213

MAR
25
2011

Natural Language Processing in a Multilingual Setting

Dr. Sandra Kubler, Director of Computational Linguistics
Indiana University

Dr. Sandra Kubler spoke on Friday, March 25th, 2011 at 1:00PM in Engineering Building III, Room 2213

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MAR
18
2011

Multiscale Geometric Methods for Noisy Point Clouds in High Dimensions

Dr. Mauro Maggioni, Assistant Professor in Mathematics and Computer Science
Duke University

Dr. Mauro Maggioni spoke on Friday, March 18th, 2011 at 1:00PM in Engineering Building III, Room 2213

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FEB
25
2011

Statistical Inference, Topology and Geometry

Dr. Sayan Mukherjee, Assistant Professor of Statistical and Computer Science
Institute for Genome Sciences & Policy

Dr. Sayan Mukherjee spoke on Friday, February 25th, 2011 at 1:00PM in Engineering Building III, Room 2213

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FEB
11
2011

Finite-dimensional variational inequalities: analysis, algorithms and applications

Dr. Shu Lu, Assistant Professor, Department of Statistics and Operations Research
University of North Carolina at Chapel Hill

Dr. Shu Lu spoke on Friday, February 11th, 2011 at 1:00PM in Engineering Building III, Room 2213

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JAN
28
2011

FACTS (Flexible AC Transmission Systems) Machine for Smart Grid

Dr. Subhashish Bhattacharya, Assistant Professor, Department of Electrical and Computer Engineering
NC State University

Dr. Subhashish Bhattacharya spoke on Friday, January 28th, 2011 at 1:00PM in Engineering Building III, Room 2213

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JAN
14
2011

Information Aggregation in Complex Networks

Dr. Ali Jadbabaie, Skirkanich Associate Professor of Innovation
University of Pennsylvania

Dr. Ali Jadbabaie spoke on Friday, January 14th, 2011 at 1:00PM in Engineering Building III, Room 2213

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Topology in the 21st Century

DEC
10
2010

Dr. Vin de Silva, Assistant Professor of Mathematics
Pomona College, California

Dr. Vin de Silva spoke on Friday, December 10th, 2010 at 1:00PM in Engineering Building III, Room 2213

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NOV
19
2010

Digital Color Management: Getting the Colors Right

Dr. Michael J. Vrhel, Color Scientist
Artifex Software Inc.

Dr. Michael J. Vrhel spoke on Friday, November 19th, 2010 at 1:00PM in Engineering Building III, Room 2213

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NOV
05
2010

From Millimeter to Terahertz Waves

Dr. John Scales, Professor of Physics
Colorado School of Mines

Dr. John Scales spoke on Friday, November 5th, 2010 at 1:00PM in Engineering Building III, Room 2213

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OCT
22
2010

An Introduction to Network Science: History, Perspective, Statistical Research

Dr. Stanley Wasserman, Rudy Professor of Statistics and Psychology
Indiana University

Dr. Stanley Wasserman spoke on Friday, October 22nd, 2010 at 1:00PM in Engineering Building III, Room 2213

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24
2010

Mathematical Modeling of Shape

Dr. Huiling Le, Professor, Mathematics
University of Nottingham, UK

Dr. Huiling Le spoke on Friday, September 24th, 2010 at 1:00PM in Engineering Building III, Room 2213

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SEP
17
2010

Metric Geometry in Shape Matching

Dr. Facundo Memoli, Postdoctoral Fellow, Mathematics Department
Stanford University

Dr. Facundo Memoli spoke on Friday, September 17th, 2010 at 1:00PM in Engineering Building III, Room 2213

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SEP
03
2010

An MCMC Approach to Lossy Compression of Analog Sources

Dr. Dror Baron, Assistant Professor, Department of Electrical and Computer Engineering
NC State University

Dr. Dror Baron spoke on Friday, September 3rd, 2010 at 1:00PM in Engineering Building

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